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PRIMARY CARCINOMA OF THE LUNG OR BRONCHUS *

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IT IS with the most sincere appreciation that I acknowledge the honor which has been paid me in your invitation to give this year the annual Balfour Lecture. Not only is it a privilege to join that distinguished group of surgeons who have preceded me in taking this means of showing their esteem for Donald Balfour, but in addition I count it a high honor to be asked to address the faculty and students of this great medical school.

The interesting coincidence that you have selected Lister's birthday as the occasion for this lecture has been one reason which has induced me to choose the subject of "Primary Carcinoma of the Lung or Bronchus" for my discourse, although the reason is far from obvious. That subject, however, represents perhaps as well as almost any other one the remarkable advance which has been made in medicine since Lister's time. At that time the condition was recognized as somewhat of a curiosity found rarely at the post-mortem table. Its diagnosis during life was practically impossible and there was no treatment which was in any sense effective. Let me quote from the well-known book, "The Diseases of the Lungs," by Fowler and Godlee,¹ which appeared in 1898, two years after Lister retired from practice. This is the same Godlee who was Lister's assistant and later became his biographer. "Primary malignant disease of the lung is a rare condition . . . (Cases of primary tumor of the lung) are extremely rare, the large majority of new growths within the thorax being of mediastinal origin." The discussion of the treatment by Fowler consists of three lines which advise that attempts should be made to relieve the most distressing symptoms. Then follow some paragraphs by Godlee on "Removal of Portions of the Lung or Pleura for Tumours and Other Morbid Conditions" which are devoted almost entirely to the theoretical possibilities of extensive pulmonary resection for tuberculosis. In the closing paragraph he states, "It is very unlikely that primary or secondary tumors of the pleura, and still less likely that tumors of the lung which do not involve the chest wall, will be diagnosed sufficiently early to warrant their removal." Two years before the book just mentioned, and simultaneously with Lister's retirement, there appeared Stephen Paget's² re-

* The "Balfour Lecture" delivered before the University of Toronto School of Medicine, April 5, 1935.

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markably interesting book entitled "The Surgery of the Chest." In it he quotes from an address by Réclus before the French Surgical Congress of 1895: "Resection of a part of the lung for primary malignant disease is not even worth discussing. An accessible, single, circumscribed growth would be a clinical wonder that would evade our present powers of observation. The utmost that the surgeon can do is, after the example of Krönlein, to follow even into the lung a sarcoma growing from the chest wall; but this will never be more than one of the brilliant exceptions of surgery." Of equal interest is a statement made by Paget himself, "It is sometimes said that surgeons fifty years hence will think as little of our results as we think of the methods of fifty years ago. So far as regards the surgery of the chest, this is utterly untrue. Fifty years ago, it had risen above the horizon, it is now nearly at its zenith. Indeed, it is possible that we may see its upward movement checked; there are signs that some of the operations that have been proposed and performed for apical phthisis and for bronchiectasis are falling out of favour with surgeons."

When one contrasts the point of view about bronchiogenic carcinoma at the time even of Lister's retirement with that which is prevalent now, about 40 years later, he finds that instead of its being a rare condition, diagnosed only at autopsy and hopeless from the standpoint of effective treatment, it is now regarded as so common as to represent somewhere between 5 and 10 per cent of all carcinomas, to be positively diagnosable in 75 or 80 per cent of cases, and finally to be possible of direct surgical attack, in spite of the gloomy prophecies of those surgeons who were probably the best qualified to speak on the subject only 40 years ago.

It will be well to pause a moment, before entering into the main discussion of our topic, to inquire into the reasons for the remarkable change in our point of view which has come about. The generally accepted idea that the condition is now far more common than formerly is usually ascribed to a supposed actual increase in its incidence due to unknown factors. Although admitting such a possibility I am not entirely willing to accept it. For I believe that many more cases are recognized now even at autopsy that formerly were considered merely as examples of the complications. Indeed, it is the complications or sequelae which are responsible for many of the deaths. A permanent bronchial obstruction from any cause leads to atelectasis and eventually to infection of the lung behind the obstruction. Large or multiple abscesses of the lung, atypical pneumonias, empyemas, *etc.*, with perhaps complicating brain abscesses, may so overshadow a small carcinoma which is blocking a bronchus that the primary lesion may be easily overlooked unless the pathologist is actually looking for it. The fact that the pathologists are now recognizing more of the small obstructive tumors, instead of stopping their examinations at the complications, in my opinion, accounts for much of the present impression that bronchiogenic carcinoma has actually greatly increased in frequency in recent years.

The present ability to establish a positive diagnosis during life in approximately three-quarters of all the cases could not have been possible without

epoch-making discoveries or inventions of two kinds, one of which was the roentgen ray by Roentgen in 1895 and the other direct bronchoscopy by Killian of Mainz in 1898, both occurring at about the time of Lister's retirement. It would not have been possible to operate in the present comparatively satisfactory manner on patients with carcinoma of the lung without the invention of Meltzer and Auer of intratracheal insufflation of air in 1909. The danger of prolonged intrathoracic operations, because of the serious effects of open pneumothorax, was not eliminated in a practical manner by the negative pressure chamber of Sauerbruch because of the complexity of the latter device which made operations of the type necessary very impractical. Again, the possibility of irradiation had to wait until the discovery of the therapeutic effects of the roentgen ray and radium. The change in the point of view of carcinoma of the bronchus is, therefore, another example of the interdependence of important medical discoveries. Just as Lister, the surgeon, made use of the important discoveries of the chemist Pasteur to revolutionize the practice of surgery, so the subject under discussion has required development in various fields of work in order to make it one which can now be approached and attacked in a practical and effective manner. This is the nature of all progress.

The fact that primary carcinoma of the bronchus is no longer to be considered a rare disease is borne out by many statistical reports, of which I shall mention only a few. Perhaps the most interesting compilations of statistics have been those by Junghanns³ and by Weller.⁴ The former, in a collected series of reports from various parts of the world, finds that this type of carcinoma represents from 2.6 to as high as 19.3 per cent of all carcinomas. In Weller's compilation a similar high percentage of primary bronchial carcinoma to other carcinomas is found. It is apparent, therefore, that the old notion that this is a rare disease must be completely discarded and one must at all times bear in mind the possibility of this condition when confronted with a patient who has pulmonary symptoms which are not clearly explainable on some other basis.

Despite the former tendency of some pathologists to think that a primary carcinoma perhaps not infrequently arises from the alveolar epithelium, especially in tuberculosis, the present conception is overwhelmingly in favor of the idea that such an origin rarely, if ever, occurs and that practically all primary carcinomas of the lung originate in a bronchus. Fried⁵ has brought evidence to indicate that these tumors originate in the basal layer of the bronchial epithelium. Tuttle and Womack,⁶ from a study of 60 of our cases, have agreed with Fried's conclusions. In the light of the newer conceptions, therefore, the fact that some of the tumors are composed of squamous cells, some are adenocarcinomas, others have "oat" cells and others present still different cellular structures or a combination of many of them, is all to be explained by a transformation of the basal cell into one of the various types of cells of which different tumors and even different parts of the same tumor are composed.

The signs and symptoms of carcinoma of the bronchus are of interest to

us as practical clinicians chiefly insofar as the early manifestations of the disease are concerned. It is the early symptoms and signs to which we should direct our chief attention because, as in cancer in other parts of the body, our main interest should lie in the disease before it is too far advanced. In other words, we should be more interested in the early evidence pointing to a suspicion of cancer than in the evidence of impending death. In our own cases the most common complaints have been in the following order: Cough, chest pain or discomfort, dyspnea, sputum, hemoptysis or streaking of the sputum with blood, and "chest colds." It is of interest, however, that five of our patients who were proven to have this condition complained of no chest symptoms of any kind. As the disease progresses then, of course, the evidences of complications of various kinds or extension of growth to other organs and of weakness, loss of weight, and cachexia all occur. If one bears in mind that in nearly all cases the tumor arises within the lumen of one of the larger bronchi the clinical picture will be easily understood. Not only will inflammatory changes in the growth produce irritations which will reveal themselves by cough and sputum but also as the tumor enlarges it will almost certainly obstruct the lumen of the bronchus. This obstruction in turn will produce an atelectasis and in the atelectatic portion of lung, sooner or later, infection will occur. The obstruction, however, does not necessarily remain complete. Some variation in the size of the tumor occurs from time to time as the result of edema. This variation in size also results in a variation in the amount of atelectasis and in the amount of drainage of pus in the infected area behind the tumor. In our experience the early symptom of pain is usually due to atelectasis. The intermittency of the bronchial obstruction in the early stages also probably explains the periods of temporary improvement which commonly occur in this condition whether the patients are undergoing treatment or not. I shall not take time to discuss the physical signs. The roentgenologic evidence is of very great importance but it is by no means uniform in all cases. In the majority of instances the roentgenogram does not reveal the tumor. Many roentgenologists, however, apparently assume that a dense shadow which they see in such a case is one produced by the tumor. This shadow, however, usually merely represents the area of atelectasis while the tumor itself, which is obstructing the bronchus, may be scarcely larger than a pea. In other cases, however, the tumor is large and sometimes reveals itself plainly on the roentgenogram. This is especially true in those cases in which it has arisen from one of the smaller bronchi and has invaded a large part of the lung tissue. Any patient free from tuberculosis, particularly if he is of middle age, who reveals on roentgenologic examination an atelectasis of one lobe, should be regarded with suspicion of the possibility of having a carcinoma of the bronchus.

The final diagnosis will usually be determined by the bronchoscope. In from 75 to 80 per cent of cases it is possible to see the tumor through the bronchoscope and to remove a piece of it for biopsy. Other methods of exact diagnosis are sometimes necessary, such as the examination of pleural fluid by the Mandelbaum method, which consists of centrifugalizing the fluid,

fixing the sediment in formalin and embedding and cutting it like any piece of tissue. Another procedure that is sometimes necessary is an exploratory thoracotomy with perhaps a removal of a piece of tissue for biopsy.

Perhaps the most important consideration in the diagnosis of this condition is to have the possibility of it constantly in mind. If it is merely thought of as a possibility many cases will be diagnosed which otherwise would be overlooked. Certainly it is true that any patient of middle age, particularly if a man, who has an unexplainable cough should have a bronchoscopic examination to see if a carcinoma is present. There is now little justification for not making exact pathologic diagnoses in most thoracic ailments. The limitations of time will forbid my entering into an extensive consideration of the diagnosis. Mention should, however, be made of the importance of bronchography by the injection of lipiodol into the tracheobronchial tree in suspicious cases.

From the patient's standpoint the most important consideration is what can be done about the condition and what are his chances of recovery. The simplest method of direct attack on the tumor is by radiation therapy. Unfortunately, however, up to the present time at least, the evidence of the effectiveness of treatment by either radium or the roentgen ray is not very convincing. There are several reasons for this; one is that many of the cases which have been reported as having been benefited by that form of treatment are not proven to have been cases of carcinoma. Again, in some of the cases in which benefits have been reported the length of time which has elapsed between the treatment and the report of the cases has not been sufficient to be a conclusive argument. It is well known, for example, that patients with this disease sometimes live for extraordinarily long periods. I have known of one patient who lived for seven years without any treatment after a positive diagnosis was established. We have had other cases in which the patient lived for as long as five years. Again, most of the reports from the radiotherapists are unsatisfactory because of the scantiness of the pathologic report. The articles in general are illustrated with copious reproductions of roentgenographic films but with no reproductions of the pathologic material. One is usually left in doubt, therefore, as to the validity of the diagnosis of carcinoma, even when a report states that a biopsy was performed and a diagnosis of carcinoma was made. Since, in many cases, the carcinoma is composed of squamous cells one might assume that radiation therapy would be an effective treatment, by analogy with its effect on other squamous cell carcinomas. Certainly, however, when the tumor has become considerably advanced there is no evidence at all that I have been able to find that radiation therapy is effective. For example, that is the recorded experience in nearly all of the clinics where a large number of these cases have been observed and treated. I refer, for example, to the published reports of Sauerbruch and Nissen,⁷ Maxwell and Nicholson⁸ and Tudor Edwards.⁹ Moreover, in 19 of our own patients who were treated by Dr. Sherwood Moore and his staff of the Mallinckrodt Institute of Radiology with thoroughly modern roentgen ray equipment not the slightest beneficial effect could

be observed. On the other hand, there are a few significant observations which have turned up here and there which make it seem possible that in the future, after our knowledge of the subject has increased still more, it may be found that certain kinds of these tumors, or rather certain cases, will respond satisfactorily to radiation therapy. For example, at the last meeting of the American Association for Thoracic Surgery, Tudor Edwards reported a case in which the primary growth was made to disappear completely with radium implanted in the tumor. The patient died, subsequently, however, from metastases. At the same meeting Allen and Smith reported a very striking case in which, after a lobectomy for a carcinoma of the bronchus, the patient showed two and one-half years after the operation a persistence of the tumor in the stump of the bronchus which was made to disappear by the implantation of radon needles. Moreover, on three different occasions since that time, at six month intervals, a recurrence or persistence of the tumor has been found and each time radium has been implanted. Again there is the case of Pancoast, Pendergrass and Tucker¹⁰ in which a "carcinoma of the ancinous-forming type possibly of bronchiogenic origin" was made to disappear by the implantation of gold radon seeds. I have also a patient, now in the hospital, upon whom I attempted a total removal of the lung because of a squamous cell carcinoma of the main bronchus of the right lower lobe. Because of dense adhesions which anchored the lung solidly to the chest wall and to the mediastinal pleura the technical difficulties became so great that it was decided merely to remove the lower lobe. In doing so it was impossible to get above the cancer without much danger of injury to the great vessels. Some cancer was, therefore, left behind. No sutures were placed in the wound, and through the large opening a massive dose of roentgen rays was given by Doctor Moore right at the stump of the bronchus without any intervening tissue of any kind. Six weeks have elapsed since this and the tumor in the bronchus can be seen with the bronchoscope to have almost disappeared. It seems to have been practically completely transformed into a scar. However, at the time of the last bronchoscopic examination by Doctor Arbuckle three radon seeds were implanted into it for additional security. So far as I know this is the only case which has received roentgen therapy in this manner. The principle may have an applicability to other cases in which the technical difficulties preclude the satisfactory surgical removal of the cancer.*

*Two weeks after giving this lecture the patient was examined again with the bronchoscope by Doctor Arbuckle and the tumor in the bronchus was found to have completely disappeared. A biopsy at that time showed only scar tissue. The patient was discharged to his home in a distant city on April 25 but he died of a metastasis to the brain on June 9. His physician wrote that there was no evidence of a recurrence of the carcinoma in the stump of the bronchus. It would seem, therefore, as if the method of giving roentgen ray therapy which was used in this case had been shown to have distinct value in making the local lesion disappear, despite the fact that the patient subsequently died of metastases. The possibility exists both in this case and in the one reported by Tudor Edwards that the metastases which caused death were already present at the time of the beginning of the treatment.

The fact remains, however, that I have been unable to find any incontrovertible evidence that up to the present time any case of primary bronchial carcinoma has been cured by radiation therapy administered in the ordinary ways, although the possibility is admitted that improved technic may in the future actually result in some cures. With this evidence before us it seems to me, therefore, that probably wide surgical removal offers the patient the best chance of recovery from this serious disease provided the operation can be considered to be a feasible one. It seems questionable to me whether the operation of lobectomy will prove to be entirely satisfactory although there are seven cases now in the literature in which there has been a survival for at least one year after operation with no evidence of recurrence. Two of these patients were operated on by Sauerbruch,¹¹ one by Churchill,¹² two by Tudor Edwards,¹³ one by Allen and Smith¹⁴ and one by Young.* In addition Roberts and Nelson¹⁵ have reported a case in which the patient was apparently free from recurrence six months after the operation of lobectomy. Neuhof¹⁶ has had four successful surgical results, but three patients died of metastases within a year after operation, and the fourth had evidence of cerebral metastasis a year later. The objection to the operation of lobectomy for this condition is that it will probably be found not sufficiently radical. It also happens that occasionally one finds that the interlobar fissures are not adequately developed and that, therefore, lobectomy would be difficult or nearly impossible. Finally, in those cases in which there are few if any adhesions the complete removal of the lung is actually about as easy from a technical standpoint as the removal of a single lobe. The complete removal of the lung carries with it the advantage of the ability to remove enlarged mediastinal nodes. Often also it will permit the operator to get closer to the trachea and, therefore, to be more certain of getting beyond the cancer. Since my first case¹⁷ of total removal of the lung at one stage for a carcinoma of the bronchus, which was performed exactly two years ago today, there have been two successful total pneumonectomies for tumor by Rienhoff,¹⁸ two by Overholt,¹⁹ two by Haight,²⁰ one by Flick,²¹ and one by Archibald.²² In addition I have had three other cases in which there seemed to be a demonstration that the operation is feasible despite the fact that the patients died a few weeks later. In one of these cases the patient, three and one-half weeks after the operation, developed a fulminant pneumonia which proved fatal in 36 hours although she had had a normal temperature for two weeks and seemed entirely out of danger. Another one died, also of pneumonia, three weeks after the operation, and the third patient died of a cerebral metastasis. The cases of Rienhoff were apparently not carcinoma but they were cases of tumor. From the standpoint of feasibility of the operation they are of as much value in this discussion as if the operations had been performed for carcinoma. There are thus altogether nine cases of successful

* A recent letter from Mr. W. Arthur Mackey of Professor Young's Clinic states that the patient returned with extensive involvement of his mediastinum three years after the lobectomy.

removal of the whole lung for a tumor performed in one stage which are known to me. Doubtless there have been others which have not yet found their way into the literature or which have not come to my attention. In addition there have been several cases of total removal of a lung for bronchiectasis, but these operations have been performed in multiple stages and for the most part have consisted merely in ligation of the blood supply so that the lung could slough out. Accordingly they are not included in this discussion of total pneumonectomy. The operation, therefore, of total removal of the lung would seem to be one which is practicable from a technical standpoint. The principal technical difficulties are presented when there are extensive adhesions. As improvements in methods are developed, the range of operability will undoubtedly be increased and the operative mortality lowered. Too short a time has elapsed since the operation on any of these patients to permit any deductions concerning permanent cures. My first patient, however, upon whom I operated two years ago is perfectly well and is carrying on a busy obstetric practice.

The study made by Tuttle and Womack of our material at the Barnes Hospital has an important bearing on the question of operability. It was based on a careful review of 44 cases in which the diagnosis of bronchiogenic carcinoma was proven by either biopsy or necropsy, from the records of which it was possible to make certain deductions. Up to the time of their study, a year ago, we had made a diagnosis of primary bronchiogenic carcinoma in 150 cases at the Barnes Hospital. In many of them, however, the diagnosis was based on merely clinical and roentgenologic findings. In some of them, in spite of a bronchoscopic examination, the tumor could not be visualized because it arose in a bronchus too small to admit the instrument. In others the patients either refused to undergo the necessary procedures to establish the diagnosis or it seemed unwise to subject them to the proper examinations because of the advanced state of the disease. In 60 cases, however, a positive diagnosis had been made by the examination of tissue. The 44 cases were selected from the larger group both because in them the diagnosis was definitely established and because of the generally satisfactory nature of the clinical histories and records. From the study by Tuttle and Womack certain important facts seem to stand out which have not hitherto been appreciated. For example, the course of the disease as well as its symptoms depends to a large extent on the portion of the bronchial tree in which the tumor arises. Tumors of the major bronchi give earlier symptoms, extend more slowly, and are more amenable to surgical treatment than those which arise in the minor bronchi and the lung periphery. For example, in 23 cases of tumor of a major bronchus the average duration of life was 26.3 months, and two cases lived for 60 months; on the other hand, in 21 cases in which the tumor arose in a minor bronchus or at the periphery of the lung the average duration of life was only 7.3 months, and the longest duration of life of any individual in the group was 33 months. Also, as might be expected, the same relationship was found to hold true in regard to the

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bronchoscopic visualization of the tumor. For example, in those tumors which could be visualized the average duration of life was 33.9 months, and in those which could not be visualized the average was only 13.7 months. The reason for this difference is perhaps not so mysterious as it seems. Apparently it is concerned with the presence of cartilage in the walls of the larger bronchi. The cartilage seems to provide a rather effective barrier which prevents the early breaking through and spread of the tumor.

Their observations made concerning metastases are also interesting. There seems to be a much greater tendency for bronchiogenic carcinoma to invade blood vessels and, therefore, to be disseminated through the body by the blood stream than occurs with carcinoma arising in other structures. There is also, however, the usual tendency to invade the regional lymphatic nodes and consequently one of the early locations of metastatic growths is in the mediastinal lymph nodes. The dissemination of the tumor throughout the body by way of the blood stream leads to the development of metastases in particular organs to a marked extent. The occurrence of metastatic lesions in 30 of our cases, in which a complete autopsy was performed, is seen in Table I.

TABLE I
FREQUENCY OF METASTASES IN VARIOUS ORGANS
A Study of Thirty Autopsied Cases

Organ	No. of Cases	Percentage
Liver.....	13	43.3
Adrenal.....	10	33.3
Brain.....	7	23.3
Kidney.....	8	26.6
Lung.....	7	23.3
Pancreas.....	4	13.3
Spleen.....	3	10.0
Bone.....	2	6.6
Ovary.....	1	3.3
Intestine.....	1	3.3
Skin.....	1	3.3

The fact that in one-third of the cases there were metastatic growths in one or both adrenals is particularly striking. In a similar study Dosquet²³ found the adrenal glands involved in 21.8 per cent. This was contrasted with an incidence of only 4.5 per cent of metastases to the adrenals which he found in carcinoma arising elsewhere than in the bronchus. The brain is another organ in which metastasis is much more frequent in bronchiogenic carcinoma than in carcinoma arising in other parts of the body. Thus in 23.3 per cent of our cases there were metastases in the brain. Those tumors which arise towards the periphery of the lung in our series seemed to develop more metastases in distant organs than those which arose in the larger

bronchi. The possibility of unrecognizable distant metastases will always make the decision to subject a patient to a radical operation more difficult.

Raquin and Neuhof²⁴ are inclined to regard those cases arising at the periphery of the lung as more suitable for operation than those which arise from the larger bronchi. It would seem, however, that they make their decision largely on the fact that in the former type of case the regional lymphatics are less likely to be involved. They comment on the frequency with which distant metastases in other organs are found in that type of case, and it would seem to me, therefore, that their observations are in agreement with those of Tuttle and Womack but that their conclusions regarding the operability are in disagreement with ours. In other words, it would seem to me, in general, that the chance of obtaining a complete eradication of the tumor is greater in a case in which the cancer arises in one of the large bronchi than it is in a case which arises in one of the smaller bronchi or at the periphery of the lung. Five cases in which Neuhof performed an operation would seem to add some justification to the conclusions which I have just made. Three patients died within a year of metastases to distant organs after the removal of the tumor. One death occurred on the third postoperative day and in the fifth case, still living at the time of the report, a little more than a year after the operation, there were symptoms suggestive of a cerebral metastasis.

One of the most discouraging results from the study of any large series of cases is the revelation that nearly all of them have been allowed to progress to an advanced state without so much as a suspicion in the doctors' minds of the true nature of the condition. One can forgive an attending physician for not establishing the diagnosis of bronchiogenic carcinoma because of the expert teamwork that is sometimes necessary. It seems difficult, however, to excuse him when he does not even take the possibility into consideration in a case of unexplained cough which has arisen insidiously in a patient of middle age or older. If the medical profession, as a whole, should appreciate the frequency of this condition, and the necessity and the desirability of taking prompt measures to establish the diagnosis in a suspicious case, probably a great many of the patients might be saved. It is a matter of the greatest importance that educational campaigns should be conducted to inform the general medical profession of the principal signs and symptoms suspicious of this condition and to get them to appreciate that bronchiogenic carcinoma is so frequent that its possibility must always be considered when dealing with a patient with unexplained cough.

The change in the point of view of the profession concerning this condition is well illustrated in a recent experience of ours. From one small city of approximately 100,000 inhabitants not far from St. Louis we have had five patients with bronchiogenic carcinoma within two years. There is nothing peculiar about that city which would make the incidence of the disease any greater there than elsewhere. The true explanation probably lies in the fact that the first patient of the five was a well-known doctor from that city upon

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whom we made a positive diagnosis which had previously not even been thought of as a possibility. This fact attracted some attention among the local profession and they have, therefore, been on the alert to recognize other cases. Moreover, we feel that these five patients do not represent, by any means, all of the cases of bronchiogenic carcinoma which have arisen in that city during the time mentioned. The probability is that there have been many more, but the incident tends to show what can be accomplished by the education of the profession to the knowledge of the necessity of thinking of the possibility of bronchiogenic carcinoma.

I am sorry that the limitations of time have prevented me from discussing other phases of this interesting subject of primary carcinoma of the bronchus. I have purposely omitted many features and I have intentionally refrained from a discussion of the various aspects of the operative technic because my desire has been chiefly to emphasize what seemed to me to be the most important features, namely, that the condition is common enough to constitute somewhere between 5 and 10 per cent of all cancers and therefore to be of the same order of frequency as carcinoma of the colon and rectum, that in the great majority of cases it can be positively diagnosed and, finally, that apparently it is not necessarily a hopeless disease. There is good reason to think that direct surgical attack will save many of the victims of this disease, and it is possible that certain other cases will be benefited by some form of radiation therapy.

Finally, I might say to Lister's ghost, if it happens to be present on this occasion, that we are apparently on the verge of another surgical triumph which was probably not even thought of by Lister himself but which was, nevertheless, made possible by the brilliant conceptions of that great benefactor of humanity.

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THE SURGICAL RISK*

WITH SPECIAL REFERENCE TO THE CARDIOVASCULAR SYSTEM

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WE HAVE today reached the place in surgery where, happily, infection is no longer a major concern. Likewise the technic of surgical procedures in nearly all fields has become standardized and there also lies before the surgeon a wide choice of various types of anesthesia. There still is, and probably always will be, room for improvement in technical procedures, but our chief concern is not with these, but with the responsibility of keeping the operative mortality and morbidity to a minimum.

Every surgeon of judgment realizes that this is a complex problem. A short time ago, learning the development of the then new technical procedures in most every field, surgeons were chiefly expected to be anatomists and pathologists. Today they must, in addition, be physiologists, and are expected to have at least a working knowledge of biologic chemistry and bacteriology. In the labor of building up that much-to-be-desired attribute, surgical judgment, surgeons are no longer expected to go ahead alone. Today they turn to their colleagues in many different fields before giving a final opinion as to the operative risk of the patient in question. According to the latest mortality statistics, heart disease is the chief cause of death in our country and any defect in the cardiovascular system is a major concern to every surgeon in estimating the operative risk. Consequently, among those associates who can give the surgeon considerable help, the cardiologist occupies a foremost position.

We have advanced considerably since the days when a stethoscope to the chest in the anesthetizing room was considered sufficient to determine the risk of the patient from the cardiac standpoint. Although the functional capacity of the kidneys was fully investigated, until recently the functional capacity of the myocardium has been overlooked and stress laid on existing valve lesions.

Today, it is of the utmost importance for the surgeon to view heart disease in the light of the newer concepts. In the past 30 years the knowledge of cardiovascular disease has advanced considerably. A newer cardiology has sprung up which has discarded many of the older misconceptions, which, while new, are simpler, more logical, easier to learn and this does not exclude the graphic method of electrocardiography. We believe that fully 90 per cent of the hearts that come under the surgeon's care will be found easier to diagnose and treat if viewed in the light of these newer beliefs.

* Read before the Philadelphia Academy of Surgery, January 14, 1935.

To do this a few of the old beliefs should be abandoned. The circulation is not a simple problem in hydraulics and the heart is not the only motive organ. The peripheral circulation has a great deal to do with the phenomena noted in many surgical patients. The capillaries are receiving the study they richly deserve and many investigators are at work on the problems relative to the autonomic vasomotor centers, which operate, to a large extent, independent of the heart. These mechanisms are operative in shock—a problem receiving a vast amount of surgical study.

If the older classic views of the circulation are revised and the problems presented viewed in the light of the newer physiology all accidents will not be blamed on the heart. Many of the "heart deaths" on surgical services have no feature, when reviewed, that suggests the heart as the principal cause. Many of these deaths are due to peripheral circulatory disturbances, shock, hemorrhage, effect of the anesthetic, or may result from overlooked pneumonia or sepsis. It does not follow that, since the heart of the operated patient has stopped beating, something must have been wrong with the organ.

So, at a time when the surgeon is on the threshold of receiving many more than the usual number of cardiacs on his service, due to the newer studies pointing to the major rôle of the thyroid gland in heart disease, we have considered it advisable to take up for brief consideration a few aspects of the problem of the cardiac risk in surgery.

THE CARDIAC STUDY.—What constitutes the proper study of heart cases on surgical services when operative procedures are contemplated? We have already indicated the folly of basing any opinion on what is heard over the heart by the use of a stethoscope. Good risks with well-established valve lesions may give plenty of murmurs for classification, whereas poor risks may easily slip by if this method and this method alone is used to classify the cases. In recent years, in heart clinics all over the country, order has been brought out of apparent chaos by the use of a system of nomenclature suggested by the American Heart Association. Using this system, certain pertinent questions concerning the heart are recorded and the cardiac diagnosis is viewed from the standpoint of etiology, anatomy, physiology and functional capacity. When this is done the way is paved for viewing the problem of the surgical risk from a place of much greater vantage.

We suggest a small form which follows this system (Chart I), to be filled out by the surgeon and the cardiac consultant before operation. This enables both to cooperate in a preoperative survey and may avoid the necessity of calling for help when the patient is in extremis postoperatively. From the standpoint of the surgical risk you will notice that this form emphasizes the patient's history in regard to the subjective symptoms of dyspnea and chest pain. Answers to these questions, recorded preoperatively, are more important in some types of heart disease, in forming a correct opinion of the patient's risk, than any murmurs or thrills or sounds which may be discovered over the precordium.

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CHART I

PREOPERATIVE CARDIOVASCULAR CONSULTATION SHEET

Name: _____ Age: _____ Service of: _____
 Occupation: _____
 Surgical diagnosis: _____
 Operation contemplated: _____
 Past medical history (Résumé): _____
 Family history of cardiac disease? _____

THE CARDIOVASCULAR STATUS

1. Symptoms

Dyspnea or chest pain (check)	On level
	On grade
	On stairs
	On hurrying
	Against the wind

Cardiac pain { Location
Duration
Radiation

Constriction of chest?

Duration of above symptoms:

Are they stationary or progressive?

Is cardiac failure present?

Edema?

Its extent:

EXAMINATION OF THE CARDIOVASCULAR SYSTEM

Blood pressure: Systolic	Diastolic			
Peripheral vessels (check): Barely palpable	Thickened	Tortuous	Calcified	
The retinal vessels (if examined):				

Heart:

Size (record position of apex beat if palpable):

Thrill (location and time):

Heart sounds (intensity; splitting):

Murmurs (location, transmission in erect position and in recumbency):

The rhythm:

Result of electrocardiographic study:

Result of chest x-ray or fluoroscopy:

Orthodiagram:

Cardiovascular diagnosis { (A) Etiologic
(B) Anatomic
(C) Physiologic
(D) Functional capacity

The grade of risk:

Result of operation:

Cardiovascular condition on discharge:

Cardiovascular prognosis:

We often speak of the stress and strain of the operation on the heart, yet this is hardly greater than the work the heart does during the normal activities of any day. If the patient tells us he has no symptoms or shortness of breath or pain, we can be reasonably certain that he will go through the anesthesia and operation with little or no difficulty. We must remember that, even in normal people, there are seen during operation disorders of the

cardiac rhythm, rapid (sometimes paroxysmal) heart action, low blood pressure, respiratory disturbances and cyanosis. These symptoms may arise from a poorly administered anesthetic and the heart may be blameless in their causation. That dilatation of the heart is responsible for the rapid heart actions which are sudden in their onset is a time-honored idea that must be discarded. Curiously enough sudden, rapid heart rates of paroxysmal tachycardia, flutter or fibrillation are many times not cause for alarm, cannot be considered as cardiac emergencies and usually cease spontaneously in an hour or so. Low blood pressure may be the cause of the rapid thready pulse the surgeon many times records and the cause lies in the peripheral circulation and not in the heart. The respiratory changes that are met with may be due to the action of the anesthetic on the respiratory center. In other words, the symptoms that are commonly recorded as cardiac arise, in many instances, from other causes. When we see the skillful anesthetist take patients through long operations with no change in the heart rate, mechanism of the heart beat and with little or no change in the blood pressure and no visible venous engorgement, we realize the importance of choosing the anesthetist and the part the anesthetist has in making the burden borne by the heart indeed a light one.

The features then of a complete heart study before operation consist of an inquiry into the patient's symptoms to determine myocardial function, a survey of the patient's past medical history to search out diseases which are known to affect the heart, a record of all the physical signs elicited and, if possible, fluoroscopic and electrocardiographic examinations to complete the picture. Then comes the review of the case with the surgeon and the consideration of the operation contemplated and a frank discussion of the indications in the light of the prognosis of the existing cardiovascular disease.

THE SURGICAL RISK.—We have, by following the above suggested plan, made a diagnosis under etiology, anatomy, physiology and estimated the functional capacity from the patient's history and findings and are now in a position to formulate certain clinical rules in regard to the surgical risk. At the outset we can emphasize the fact that, for the purpose of operation and anesthesia, a heart which carries its daily burden well without excessive dyspnea or chest pain is equivalent to the normal organ. As Marvin has stated, "No matter what size the heart may be, no matter what thrills or murmurs may be present, and no matter in what direction they are transmitted, if the patient is leading a life of moderate activity without symptoms, the heart may be regarded as the equivalent of a normal one and it may be safely assumed that it will behave properly during operation and anesthesia." There is one exception to this rule. Syphilitic heart disease with advanced aortitis and aortic insufficiency is the type of heart disease where the patient is apt to die suddenly. The mechanism here is rather imperfectly understood, but it is a common experience of clinicians and surgeons who deal with this type of heart. Patients with angina pectoris should likewise be classified as poor or Grade III risks. Here, however, evidence is obtained

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in the patient's history of the poor functioning of the myocardium, and the easier the pain is produced the poorer the risk and the shorter the duration of life as a rule. Patients with complete heart block, which is in itself evidence of myocardial damage, usually cannot carry on the ordinary activities of life, and this class of patients we group with the luetic and angina cases as Grade III risks (Chart II). The well-compensated rheumatic heart with

CHART II

THE GRADE OF RISK BASED ON A STUDY OF THE FUNCTIONAL CAPACITY

Grade I	Class I of American Heart Association	Good risk. Here are included patients in whom ordinary physical activity does not cause undue fatigue, palpitation, dyspnea or chest pain, all cases of well-compensated valvular heart disease except the syphilitic, hypersensitive heart disease with no renal involvement.
Grade II	Classes 2 (a and b) of American Heart Association	Risk fair with careful medical supervision and preoperative treatment. Emergency surgery only until risk improved. Here we group cases of beginning congestive failure and angina. These cases all show undue fatigue, palpitation, dyspnea or chest pain on <i>ordinary</i> physical activity. All patients classed here can have risk improved to Grade I if operation not emergency.
Grade III	Class 3 of American Heart Association	Surgery contra-indicated. These patients show signs of cardiac insufficiency at rest or signs of active heart infection. They cannot carry on <i>any</i> physical activity without discomfort. Here we include severe angina patients, cases of cardiac decomposition with edema and severe dyspnea and patients with recent coronary occlusion with marked reduction of the myocardial reserve.

or without valvular disease as well as the uncomplicated hypertensive heart we have found stand operation and anesthesia extremely well. When râles at the lung bases, upward trend of the venous pressure readings, and other signs of congestive failure can be elicited, we consider the patient unsafe except for emergency surgery.

CAN THE ELECTROCARDIOGRAM HELP THE SURGEON?—The electrocardiogram can be of great help to the surgeon in its use as a guide to the prognosis of the patient's heart condition. Studies of T-wave negativity are very helpful in establishing at times life expectancy, as has been pointed out by Willius. The electrocardiogram can also be expected to show evidence of recent coronary occlusions which, at times, cannot be diagnosed by the ordinary clinical methods. Muscle damage may also be picked up which will at times aid in evaluating the symptoms of the patient. It is evident that the electrocardiogram cannot be expected to furnish the surgeon with a machine diagnosis. The tracing is of no value in most instances unless considered along with the patient's clinical history and findings, as recorded on the study sheet. The cardiac arrhythmias may be very nicely studied by using the electrocardiogram, but after more careful clinical observations, surgeons should not

have to depend on this instrument for a diagnosis of these irregularities. It may be broadly stated that none are important except heart block and pulsus alternans. The sudden onset of one of the paroxysmal, cardiac arrhythmias, such as auricular tachycardia, auricular flutter or auricular fibrillation may cause the surgeon great alarm. These mechanisms are apt to occur at any time, and usually do not constitute cardiac emergencies in the strict sense of the term. The patient may give a history of paroxysms of tachycardia for many years which have appeared and disappeared very quickly and caused the patient little or no inconvenience. It may be assumed that these mechanisms will behave in the same way when the patient is in the hands of the surgeon. The electrocardiogram is helpful in differentiating these various types of disorder of the heart beat, and perhaps throws some etiologic light on the condition. If the patient is let alone, these mechanisms usually cease as quickly as they start and in the absence of circulatory failure they should be allowed to do so.

CAN RISK BE IMPROVED?—Coöperation of surgeon and cardiologist certainly makes it possible to improve the risk by proper treatment. Early congestive failure certainly calls for delay in operation wherever possible until the evidences are cleared up by rest and digitalis. When this result is achieved the risk is greatly improved. Venous pressure readings will sometimes aid in controlling the digitalis medication and in deciding the time to operate where the usual signs of congestive failure are obscured. This same rule holds good for obstetricians when their patients, usually rheumatic with mitral stenosis, come in with congestive failure. Then the clearing up of the evidence of circulatory stasis should be accomplished before the patient is delivered.

The surgeon sometimes shows considerable indecision in the use of digitalis in improving the cardiac risk. We believe that digitalis is indicated only in the presence of some evidence of congestive failure or when permanent auricular fibrillation is present with a high ventricular rate.

Some surgeons give digitalis routinely before operation in all their cardiovascular cases. This they do in spite of the fact that the patient's history shows no functional impairment in the circulation in carrying on the ordinary activities of life. If this evidence of a good circulation is present how can it be further improved by the use of the drug? It may be that surgeons believe that digitalis has an effect in sustaining blood pressure and in increasing the "myocardial tone." This, statistics have shown, the drug fails to do. Likewise, there is no evidence that digitalis prevents hypostatic pneumonia in old people undergoing surgical operation. On the other hand there is evidence that digitalis in normal people actually causes a decrease in the volume output of the heart. We believe that digitalis should be given in its full dosage or withheld altogether.

CARDIAC ACCIDENTS.—In those patients giving a history of angina pectoris or who have had one or more coronary occlusions, the surgeon is presented with the possibility that the same accident may happen under his care

as it would during the ordinary exertions of everyday life. We do not believe that surgical operations are frequently the cause of the precipitation of such complications. However, should the operation be attended by such complications as sepsis or pneumonia, these factors may be potent in precipitating the cardiac complication. When surgery is imperative in the midst of an attack of coronary thrombosis it must be expected that the mortality will be high just the same as it would be if the patient were under the care of the cardiologist in the medical ward. The sudden death in syphilitic heart patients, undergoing major surgery, may be expected and cannot be prevented. The chief cause of death among cardiac patients after coronary occlusion is perhaps congestive failure, which occurs usually during the postoperative period. Embolic accidents and cerebral accidents are the next most frequently met with. It may also be stated that heart cases react particularly badly in the presence of postoperative infection or pneumonia. Congestive failure can, perhaps, be made an insignificant factor in the causation of death in the cardiac cases, if it is recognized and promptly treated before operation.

CARDIAC DISEASES SMULATING SURGICAL EMERGENCIES.—Careful study of the patient's cardiovascular system will usually prevent these mistakes in diagnosis. Cases of acute coronary occlusion have been known many times to masquerade as surgical emergencies. Many times the features of these cases, including abdominal rigidity, pain, leukocytosis and shock, have been very typical of ruptured gallbladder or ruptured duodenal ulcer or acute appendicitis. A careful cardiac check-up with electrocardiographic examination and a careful physical examination of the chest will give the surgeon the clue as to the real nature of the emergency. In children particularly, acute pericarditis may closely simulate acute appendicitis. In all these cases, the abdominal reference of the pain, with its accompanying rigidity, has been the confusing sign. So it behooves the surgeon in these cases to make a supradiaphragmatic survey with the help of the cardiologist before scheduling a patient for operation. Likewise, if the surgeon is not constantly on the lookout for the heart of congestive failure, the signs of which are just as easy of recognition for him as for the cardiologist, the acutely swollen liver may at times be mistaken for gallbladder disease.

Factors in Treatment.—We have already spoken at some length with regard to the use of digitalis in improving the surgical risk. We have tried to give its indications and contra-indications. Another valuable drug not generally appreciated, possibly because its contra-indications have been greatly exaggerated, is quinidine. At times, the use of this drug may prove a life saving measure. There are instances, chiefly occurring postoperatively, where abnormal cardiac mechanisms, such as paroxysmal tachycardia, auricular fibrillation or flutter come on in the sclerotic heart with little cardiac reserve and then are not harmless but are the outstanding factors in precipitating an attack of congestive failure. In these instances, the quicker the heart is relieved of its excessive rate and the sooner diastolic filling can be prolonged, the better will be the outlook for the patient. Should the rapid rate be pro-

longed in a heart such as described, dilatation, acute engorgement of the liver, cyanosis and all the signs of cardiac failure can quickly appear. Relieving the heart of the burden of this abnormal mechanism can be accomplished by the prompt use of quinidine in many instances. At times, the response to the drug is quick and dramatic, the signs of congestion disappearing very promptly as the abnormal rhythm is abolished. Many times the administration of digitalis will not only be ineffective in lowering the pulse rate, but, acting on the cardiac musculature may actually prolong the paroxysm.

The treatment of the tachycardias depends on the etiology. Shock and hemorrhage should always be kept in mind, and the heart not always incriminated when the pulse rate rises. If these facts are remembered the heart will be found to be at fault fewer times, the treatment instituted will be more fitting for the incident and much digitalis will be saved.

THE SURGEON'S RÔLE IN THE PREVENTION OF HEART DISEASE.—There is something to be said about the surgeon's rôle in prolonging the life of cardiac patients. We are entering a new epoch in the treatment of cardiac cases by the procedure of total thyroidectomy. In the case of cardiac patients, irrespective of the etiology, where the course of the case or the degree of the progress of the pathologic change has reached a given level, whether the failure is anginal or congestive, we can, by total ablation of the thyroid and the subsequent lowering of the basal metabolic rate, give the circulation a chance to carry on for a greater period of time. From the results already reported, it is safe to say that the surgeon is about to assume a more important rôle in the treatment of cardiac disease.

When the amount of prevented cardiac infection through the judicious removal of infected tonsils and adenoids, as well as through the successful removal of infected gallbladders, appendices and other foci is considered, to which must be added pericardial drainage and cardiolysis, we must admit that the surgeon plays no small rôle in the prevention and treatment of heart disease. The skilled removal of the thyroid gland in cases of toxic goiter reclaims many patients who have progressed as far as congestive cardiac failure and in no phase of cardiovascular management is coöperation between cardiologist and surgeon so effectively shown. If similar hand in hand advances could be instituted in dealing with other cardiac problems, considerable progress might be looked for in this field. As Rowntree has said "medical man and surgeon are doing their utmost, but too often independently."

SUMMARY

- (1) The essentials of a complete preoperative study for the determination of the surgical risk are outlined and a form is suggested to aid in this study.
- (2) A simplified grading of the risk is proposed, paralleling the terminology of the American Heart Association now in use on medical wards.
- (3) The preoperative treatment to improve the risk, the rôle of the

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cardiac drugs, particularly digitalis, the common cardiac accidents and the usefulness of electrocardiography are briefly discussed.

DISCUSSION.—DR. THOMAS M. McMILLAN (Philadelphia).—When one considers the delicate mechanism of the heart and circulation, the wonder is not that it occasionally fails during or after surgical operations, but rather that it does not fail more often under the great shock of major surgical procedure. The reason is that we are equipped at birth with a circulatory mechanism fitted not only to meet the needs of ordinary life, but possessed of a power that in children and young adults gives it a resiliency sufficient to meet almost any strain. Therefore, if one were only concerned with surgery in normal children or young adults, the question of circulatory failure would hardly ever have to be considered. However, as one grows older, the wonderful reserve of the circulation diminishes so that no one at 50 has nearly the same marvelous circulatory mechanism that was present at 20. Inasmuch as the great majority of subjects of surgical procedure are those who are approaching or have passed middle life, it is this age group in which we must mainly consider the risk that the heart introduces to surgical procedure.

Doctor Leaman has presented to us very clearly tonight the methods of study that are at present available for determining the condition of the heart. If a prospective subject of surgery under 50 years of age is studied by these methods and no suspicion of circulatory abnormality is discovered, then we are justified in feeling with relative certainty that that patient's circulation will withstand any reasonable surgical procedure. If the subject is over 50 years of age, we are not justified in being so certain; for we know that everyone at 50 has lost something in circulatory stamina that he possessed at 20: the aorta and coronary arteries are not so elastic; the nervous and reflex controls are more tricky. Therefore, one should expect that the circulations of a certain percentage of persons over 50 will fail in spite of the fact that complete study such as Doctor Leaman uses has failed to reveal definite evidence of abnormality. Such hearts are the seat of changes that cannot be discovered, and yet are potentially dangerous. Not a few of us, I suspect, have had the experience of studying patients and failing to find abnormality of any sort, only to have them develop coronary occlusions a few weeks after our negative examination. Therefore, I feel that our surgical colleagues should not expect internists to do more than express rather roughly, in percentage perhaps, the chances of a patient over 50 withstanding a major surgical procedure. If they expect a more definite or exact opinion, I fear they will be disappointed.

Now, what of the patients whom our studies have shown to have definite heart disease? Obviously one does not operate on such individuals unless an operation is essential: this not infrequently occurs, and the risks introduced by the damaged heart must be assumed. The matter of age and etiology, as well as the degree of cardiac damage, determines the risk.

It is almost a universal procedure to remove tonsils in children with rheumatic heart disease. I, personally, know of no fatalities that have followed this procedure in spite of the fact that I have often seen it carried out in the presence of gravely damaged hearts. Likewise, the seriously deranged heart of hyperthyroidism is rarely the cause of operative or post-operative death. We know from experience, therefore, that rheumatic hearts and those of hyperthyroidism can withstand a great deal of surgical interference. Generally speaking, the most dangerous hearts from the point of view of operative risk are those whose damage is the result of syphilis or of arteriosclerosis or of hypertension.

I shall not discuss further syphilitic or arteriosclerotic disease. I would like to say just a word upon the subject of hypertension. When the systolic blood pressure is persistently over 140 and the diastolic over 90, hypertension is present. It can be accepted as a fact that no heart can withstand the strain of hypertension long and remain normal. It must hypertrophy at least, and a hypertrophied heart is not a normal heart. Therefore, every time a hypertensive individual is operated upon, there is some risk of circulatory collapse. The risk, however, is more or less proportional to the degree of damage. The amount of damage sustained, however, is not always proportional to the degree of hypertension. How badly the heart has suffered and therefore how great the risk can be determined only by applying to each subject the careful thorough clinical and graphic studies that Doctor Leaman has discussed.

I believe the subject of the risk of the heart in surgery is a most profitable one for both surgeons and internists to discuss. It is a subject that is certainly most important. The rôle of the internist in helping to decide if a given heart can withstand surgery is often a most difficult one. However, I believe that careful study of the matter and the thorough application of all modern methods will do much toward lowering the mortality from circulatory failure during and after surgical interference.

DR. I. S. RAVDIN (Philadelphia).—Fitz-Hugh and Wolferth (ANNALS OF SURGERY, vol. 101, p. 478, 1935) have called attention to the improvement in the electrocardiographic picture which occurred in patients having coincident cardiac and biliary tract disease after removal of a diseased gall-bladder. They concluded, "These electrocardiographic data, together with the clinical data, indicate an apparently beneficial effect on the heart from successful removal of gallstones in these cases." We have had 16 patients all showing moderate or severe myocardial disease with only one patient dying as a direct result of the operation, and this patient died in the hospital. Several of these cases had been bedridden for months prior to operation and on the whole they were decidedly improved subsequent to operation. It is my impression, at present, that patients with evidence of moderate cardiac disease, as long as they are compensating, will stand biliary tract operations very well.

DR. WALTER E. LEE (Philadelphia).—As desirable as it would be for the surgeon to be able to obtain an accurate estimate preoperatively of the patient's cardiovascular system, I must admit from my own experience that the internist's prognosis is far from infallible, nor are they always of help in making a differential diagnosis between coronary thrombosis and abdominal catastrophe. Only last month we had two cases in which we disagreed with the internist. In the first one the surgeon diagnosed coronary thrombosis and the internist disagreed. At the end of 18 hours an electrocardiogram showed characteristic changes of coronary disease. This man was not operated upon. The second patient was diagnosed by the internist as a case of coronary thrombosis and was not operated upon, and 48 hours later he developed all of the characteristic symptoms of a perforation into the peritoneal cavity. I do not know of any surgical problem in which we need more help than in the differentiation between coronary thrombosis and abdominal catastrophe, and I cannot feel that at the present time we have as much help as we would like to have from the internist.

DR. EDWARD J. KLOPP (Philadelphia) recalled a man who was sent into the hospital with a diagnosis of a perforated duodenal ulcer. We thought

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the man had coronary occlusion, whereupon an internist of national reputation was consulted and he thought he had a perforated ulcer, but it was my impression that he was too ill to be operated upon immediately. The following day he was autopsied. He had both a perforated ulcer and also a complete coronary occlusion.

DR. JOHN S. RODMAN (Philadelphia).—I have been very much interested in Doctor Leaman's work with us during the last year, he certainly has helped us a great deal, and has added to my comfort in assuming the responsibility for the risk in these patients. One of the outstanding points in his paper, I believe, is that if the handicapped heart patient can go about without discomfort, he is apt to go through any surgical procedure safely. This we have seen happen repeatedly. It is an important new phase in our modern technic to estimate the risk by electrocardiographic study. The heart with valvular lesions, providing it is compensating, will stand any surgical risk within reason. It is often impossible to pick up muscular damage without the help of the cardiologist, and if you do, it is life saving surgery to do the least surgery possible. A good example of this is the gallbladder case for whom it is better to do a cholecystostomy than a cholecystectomy if cardiac damage is found.

THE RENAL PHASE OF SURGICAL RISK*

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THE renal phase of surgical risk is a subject to which the surgeon himself has contributed very largely and it does not represent simply a phase of internal medicine.

The greatest contribution to our knowledge of the kidney in disease was made by that famous English clinician, Richard Bright. Although his laboratory equipment consisted of but a spoon and a candle, he established the clinical significance of albuminuria. He collected under one roof all sorts and kinds of patients suffering from albuminuria. On these patients he took careful histories, made thorough physical examinations and did urinalyses, such as they were in his day. He followed those who died to the autopsy table. He taught the medical profession the clinical picture, the diagnosis, the prognosis and treatment of nephritis, Bright's disease. He went even further and indicated the great fundamental problems concerned in nephritis. If we, as medical men, had had the wit to read between the lines, we might have known as much 50 years ago about kidney disease as we know today. Now, as in the day of Bright, every surgical case should be subjected to a routine physical examination, a careful history, and a urinalysis both chemical and microscopic.

Recent work has revealed new information relative to urinary proteins. Normally albumin is lacking in the urine but in health it may reach as high as 40 to 50 mg. per day. Increased urinary protein usually indicates increased permeability or injury of the glomeruli. As a rule, in most diseases of the kidney, albumin is the predominating protein in the urine. It may reach as high as 50 Gm. a day in certain cases of nephritis, especially in nephrosis, thus robbing the body of its albumin content. In certain other diseases globulin predominates, particularly in multiple myeloma which is characterized by a Bence-Jones proteinuria.

The protein in the urine is derived as a rule from the proteins of the blood. Normally the total plasma protein varies from 6.5 to 7 per cent. The serum albumin constitutes 4 to 5 per cent; the globulin 2 to 5 per cent and the serum fibrinogen 0.2 to 0.4 per cent. Serum albumin exerts four times as much osmotic pressure, weight for weight, as serum globulin.

In disease, fluctuations from these values are common, usually a decrease in the albumin and frequently compensatory increase in globulin. The body is capable of regenerating 25 Gm. of serum albumin per day. When the urinary loss exceeds this, the body becomes deficient in serum albumin. When this reaches a critical point, edema is apt to develop. The critical point is represented by a plasma protein of 5.5 per cent with a serum albumin of 2.5 per cent.

* Read before the Philadelphia Academy of Surgery, January 14, 1935.

Much discussion has been accorded the albumin-globulin ratio in relation to the development of edema but the reduction in total plasma protein is the most important consideration. Naturally the level of the electrolytes is also of significance.

Thomas Addis, one of the greatest students of diseases of the kidney of modern times, has given us a quantitative method for the study of the formed elements as well as for albumin in the urine. In this he has included the red blood cells, the white blood cells and the various forms of casts. He also has discovered the broad "renal failure cast" which has a marked prognostic significance in the terminal phases of the hemorrhagic type of nephritis.

The greatest progress in evaluating the renal phase of surgical risk concerns the use of tests of renal function. It behooves us, therefore, to understand the normal as well as deranged function of the kidney. The function of the kidney is to maintain homeostasis through the elimination from the blood through the urine of all excessive superfluous or waste products: (1) excretion of water and salt, maintenance of the water balance of the body; (2) excretion of end products of metabolism; (3) maintenance of acid-base equilibrium; (4) synthesis as exemplified in hippuric acid; and (5) control of hormonal content of the blood.

The work of the kidney may be summarized in tabular form as follows: All of these functions might probably be utilized in determining renal function. Many of them have already come into use in this connection.

The tests of renal function may be divided into three groups: (1) tests of excretory capacity; (2) tests of retention; (3) tests of rates of excretion. Of the tests of excretory capacity, the water test of Albarran was one of the earliest tests introduced. It is still of great importance in determining matters pertaining to dilution and concentration of urine. Chemicals have been utilized also for tests of excretion. Among these are potassium iodide, lactose, salicylates, sodium chloride, urea and sugar following the administration of phloridzin. None of these, aside from the excretion of sodium chloride and urea, is employed frequently at the present time. The excretion of enzymes, particularly diastase, is a test introduced in Germany by Wolgemuth. Finally, there are the tests based on the excretion of dyes, methylene blue, indigo carmine, rosaniline and phenolsulphonphthalein, the latter introduced in 1910. Of these, the indigo carmine test is still in common use and is of particular value in chromocystoscopy; the phthalein test has constituted the standard test of renal function during the last quarter of a century.

The tests of retention which have been employed are: (1) the concentration of ions as determined by the electrical conductivity; (2) the concentration of molecules and ions as determined by cryoscopy; (3) the level of cholesterol in the blood; (4) the level of the total incoagulable nitrogen or the total non-protein nitrogen in the blood, a test of great value; (5) the level of the blood urea which has been determined by various methods, those of Doremus, Marshall, Hench, Van Slyke, and Carr. The level of blood urea is perhaps the most commonly used test of renal function. (6) The level of creatinine,

uric acid, phosphorus and sulphates in the blood also yield significant information as to the function of the kidney. The most important of these are the level of the blood urea, creatinine, phosphorus and sulphates.

The coefficients of the excretion of various substances have been utilized for three decades. The rate of excretion of urea has been the test most commonly employed. This began with the constant of Ambard and is now utilized as the urea clearance test of Van Slyke. This is regarded by many as the most delicate index of renal function. The rate of excretion of other substances, however, may be utilized. The fractional output of phenolsulphonphthalein was advocated by Shaw. Likewise the creatinine filtration or clearance test was advocated by Rehberg and the rate of excretion of sulphates was introduced by Wakefield, Keith and Macy, all yielding an index which is just as delicate and of equal efficiency as that obtained with urea clearance. Some of the formulae now employed for determining the rate of urea level are appended (Table I).

TABLE I

Functional Test	Value Determined
Urea concentration in urine.....	U
Urea concentration in blood.....	B
Concentration ratio between urine and blood	$\frac{U}{B}$
Ambard's urea-secretory constant. Original form	B^* $\sqrt{D \times \frac{70}{\text{weight}}} \times \sqrt{\frac{U}{25}}$
Addis urea excretion ratio (maximum blood clearance)	$\frac{D}{B}$ or $\frac{UV}{B}$
Standard blood clearance.....	$\frac{U}{B} \sqrt{V}$

Other tests of renal function are the urinary concentration tests relative to food and water intake introduced by Schlayer and Hedinger and simplified by Mosenthal. The urea ratio, the ratio of urea nitrogen to total non-protein nitrogen in the blood, has always been regarded as significant. It was emphasized by Mosenthal and Bruger. The synthesis of hippuric acid after the feeding of benzoic acid was a test introduced by Kingsbury.

Acidosis and alkalosis are important relative to renal function. They are always secondary in nature and are readily revealed by the carbon dioxide combining power of the blood. One may see increasing acidosis ending in uremia and death; cases in which alkali treatment has been administered in acidosis with a clearing up of the acidosis without effect upon the progress of uremia; and cases of severe acidosis and acute nephritis with complete recovery

RENAL PHASE OF SURGICAL RISK

and return to normal of the carbon dioxide combining power of the blood and the urea nitrogen.

It is just as important to recognize alkalosis as acidosis. This is often encountered in high intestinal obstruction. By means of functional tests, especially the creatinine content and the carbon dioxide carrying capacity of the blood, it is possible to determine the extent of the risk. The effects of adequate treatment with saline solution can be followed and the best time for operation determined with nicety. Recognition of the importance of alkalosis, particularly in high intestinal obstruction, has led to the saving of many lives (Table II).

TABLE II
The Work of the Kidney

Water	Solids		Acid		Base	
	Organic	Inorganic	cc. 1/10 N	cc. 1/10 N		
	35.2 Gm.	22.7 Gm.	2548	2368		
12-1500 cc.	Urea..... 32.0	NaCl..... 14.0	P..... 925	Ca.... 365		
	Creatinin..... 1.8	H ₃ PO ₄ 2.0	Cl.... 810	Mg... 283		
	Uric acid..... 0.7	H ₂ SO ₄ 2.6	S.... 813	K.... 870		
	NH ₃ 0.7	K ₂ O..... 3.0		Na... 850		
	Hippuric acid. 0.8	Mg & CaO... 0.9				
	Rest N..... 2.2	Rest..... 0.2				

A few words should be said concerning the use of the phthalein test and other dyes given intravenously. For greater delicacy, they may be employed in this way. When the phthalein test is so utilized, 55 per cent represents the normal excretion for the first half hour, a point emphasized in the original publications. Fractional excretion at 10 to 15 minutes has been employed by Shaw, Young, Chapman and Halsted. The latter workers have employed it together with the urea clearance test and claim that it yields information identical with that obtained from the latter. Because of the simplicity of the technic, they regard it as the functional test of choice. Machado Macedo of Portugal has advocated the combining of the intravenous phthalein and the rate of urea excretion in one procedure for the determination of renal function. He regards the output of phthalein as the most delicate index in determining the rate of urea excretion. He utilized his own formula $\frac{UR}{D}$.

After 25 years' experience with functional tests, I believe that the degree of renal involvement can be determined quite accurately even by the general practitioner. In accomplishing this he will need: (1) measuring cylinders and urinometers; (2) test tubes and reagents for determining albumin and sugar; (3) microscope and slides; (4) blood pressure apparatus; (5) ophthalmoscope; (6) phenolsulphonphthalein outfit. The concentration and dilution of urine as determined by the Mosenthal or Newburgh methods reveals information of great significance. Many physicians fail to appreciate the value

of the ophthalmoscope in the study of the kidney. It should be remembered that diagnostically the retina may represent the polished surface that takes the fingerprints of disease and that prognostically it often becomes Belshazzar's wall on which the fate of the patient is written.

Another field in which real progress has been made is in roentgenography of the kidney. This often reveals unexpected information which is of greatest importance to the patient. This may be obtained at times with flat films or by retrograde urography which has to do essentially with the location of the kidneys, with the shadows of the pelvis of the kidney, of the ureters, bladder and sometimes of the urethra.

More than this is necessary. What is most needed at present is a method for revealing the total size of the kidney. This we attempted to do some years ago through the use of the intravenous injection of sodium iodide. Although our work failed of its main objective, it did result in the development of the field of intravenous urography. While this must be regarded as an important development, it does not solve one of our most important problems.

I believe that the clear delineation of the kidney by roentgenography is the next great step necessary in the understanding of the kidney in disease. In many instances I am certain it will afford information just as important and, in some respects, more important, than that revealed through the use of functional tests. In this connection we have been working with Dr. B. P. Widmann and Dr. John Lansbury and by means of six foot films have succeeded in showing the outline of the kidney, in some instances through the utilization of several films. The surface of such a kidney, obtained at autopsy, has been measured with a planimeter by Doctor Lansbury and, utilizing the formula—Area multiplied by the square root of Area divided by three—he has succeeded in calculating the weight of such a kidney within the limits of plus or minus 10 per cent. The great need is for a procedure whereby the outline of the kidney may be boldly delineated and the total kidney substance ascertained. Having failed to solve this problem to our own satisfaction, we are eager to see it taken up by others or to have suggested to us some method whereby this may be accomplished.

It is apparent that in determining the renal phase of surgical risk a broad approach must be made involving many considerations. Among these should be mentioned (1) the nature, duration and severity of the disease present; (2) special considerations relating to the condition of the kidney, cardiovascular system, urinary tract, lungs, blood and intestine; (3) the results of the renal functional tests and urography; (4) the type of operation involved; (5) the caliber of the surgeon and his organization. The most important consideration from the patient's point of view is probably the selection of the surgeon. If the surgeon and his organization are all that they should be, all the important requirements of the particular case will receive adequate consideration. This will include preoperative care, the choice of anesthesia, the severity of the operation and the nature of postoperative management. When all goes well, the surgeon will suffice but when difficulties are encountered, the help of the internist may prove of value.

PANTOCAIN IN SPINAL ANESTHESIA*

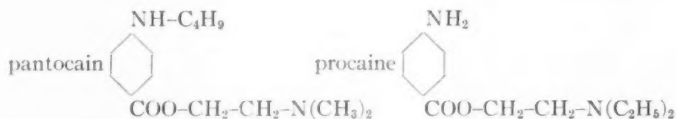
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SPINAL anesthesia has appealed to surgeons through its facilitation of their work due to the superior relaxation it provides. The use of procaine and its equivalents novocain, neocaine, and spinocaine has made the "spinal belly" a descriptive term. On account of its relatively short duration, procaine, however, was found inadequate in some of the very procedures where it would have been most appreciated. The search for an anesthetic of more prolonged action has led to the examination of a number of drugs among which was pantocain.

Its structural formula is similar to that of procaine from which it is derived.



It is supplied commercially in 1 per cent solution as a colorless liquid with a toxicity six times that of procaine,¹ but its smaller effective dosage makes it no more toxic in practice. We are told that when a lethal dose is given intravenously animals invariably die of respiratory paralysis and that its effect on circulation is not to be feared as doses many times that used intraspinally are required to cause a significant drop of blood pressure.² It must be remembered that these data as to toxicity apply to intravenous rather than intrathecal use. The specific gravity in 1 per cent solution is 1.0068 at 25° C. as compared with spinal fluid which may vary under normal conditions from 1.001 to 1.009. So the solution, while designed to be of equal density, may be actually heavier or lighter than a particular spinal fluid.

As this relation is important to the operator in a given case, we have employed a test solution devised by Dr. Hans Clarke, consisting of a mixture of xylol and chlorobenzene in proportions to have a specific gravity equal to that of the pantocain solution. This fluid does not mix with spinal fluid. Therefore, when spinal fluid is dropped into a tube of the test solution it is found to be heavier or lighter than pantocain, depending upon whether it sinks or floats.

The drug is administered with the usual sterile precautions in the lateral recumbent position. Ephedrin (50 to 125 mg.) is injected into the erector spinae muscles through a novocain wheal and through a similar wheal over

* Read before the New York Surgical Society, March 13, 1935.

an interspace of the lumbar spine appropriately chosen to give the desired level of anesthesia, as the second lumbar; a fine gauge needle (No. 22) is introduced into the subdural space. One drop of spinal fluid is used to determine its relative specific gravity. When five minutes have elapsed from the time of ephedrin injection, 2 cc. of pantocain solution plus an equal amount of spinal fluid are slowly injected. As little as .5 cc. suffices for the lowest anesthetics and dilution with spinal fluid is used only to raise the level of anesthesia. The patient returns to supine position on a flat table and the head is raised to prevent the drug from reaching the cervical region, providing of course the spinal fluid is lighter than the drug, as is almost always the case. The table is not tilted unless the operation demands Trendelenburg position and this, not until 20 to 25 minutes have elapsed, which is the period required for fixation of the drug. Almost immediately after injection a satisfactory anesthesia to the nipple line will be found established.

This anesthesia lasts about three hours, though by appropriate modifications of technic a range of three-quarters to five hours can be produced. The patient usually dozes throughout the operative procedure due to premedication with nembutal or some other barbiturate plus morphine. Many prefer paraldehyde on account of the uncertain action of the barbiturates which sometimes excite. The patient breathes quietly but on request takes deep inhalations. His blood pressure rises as the ephedrin takes effect perhaps 20 Mm. and is lowered with the spinal injection to his anteoperative pressure or even slightly below. His intestinal caliber is diminished but the collapsed or ribbon gut seen with procaine is absent. He exhibits the typical abdominal relaxation seen in all spinal anesthesia, but may respond to traction on the mesentery by retching or even vomiting, unless anesthesia reaches the second dorsal interspace. The operation may be completed without especial haste. He recovers from his drowsy state slowly without nausea and unless contra-indicated by the nature of the operation may take fluids immediately. His head is not raised for 24 hours. The anesthesia clears from above downward and disappears last in the feet and lower abdomen, that is, in the area supplied by roots at the site of injection.

There is no dearth of experimental data on the action of spinal anesthetics in general and some on pantocain in particular, although it is sometimes conflicting. It might be profitable to compare it with clinical observations.

It is not universally accepted that spinal anesthesia is due to paralysis of nerve roots. It has been thought of as a cord paralysis. It was thought that if a band of anesthesia could be produced, the point would be proven. This was accomplished by injecting 1 cc. of 1 per cent pantocain in the sixth dorsal interspace for a chest operation. Anesthesia extended from the second dorsal interspace to the navel, but below this point there was no sensory or motor paralysis.

If one considers the dural sac of a horizontal patient as a tube containing a watery fluid of 1.004 specific gravity, when a small amount of fluid of specific gravity 1.006 is introduced, it will lie beneath the spinal fluid and bathe the

posterior roots, except as it may diffuse anteriorly before being taken up into nerve tissue. By diffusion we do not mean the molecular phenomenon of physics. This process is too slow to act within the period when the drug is free. We refer simply to a mechanical dispersion of the drug by the swirling of rapid injection.

When a typical spinal anesthesia is given by injection through a lumbar interspace it is usually noted that the anesthesia begins in the feet and perineum and progresses cephalad. Similarly it clears from above downward, disappearing last in the roots at the site of injection. This must mean that the concentration of the drug at a given spinal root determines the duration of its corresponding area of anesthesia and that the greatest concentration is at the site of injection. Involvement of other levels then depends upon diffusion or upon flow by gravity along the posterior trough of the dural tube. An example of the spread by flow is found in the many observations of anesthesia to the second cervical without embarrassment of respiration. The drug evidently travels from the twelfth dorsal by flow along the posterior aspect of the cord. If there were an appreciable concentration of the drug in contact with anterior roots these would be involved with paralysis of the phrenics as it passed cervical three, four and five. To be sure, another factor may be involved—greater susceptibility to local anesthetics of sensory as compared with motor fibers. The necessity for slow injection to minimize diffusion is apparent and the danger of lowering the patient's head prematurely is seen to depend upon the flow of the drug to a higher level than planned.

All these phenomena have been demonstrated visually, by injecting into a horizontal tube containing a colorless liquid a somewhat heavier one of contrasting color.

The drop in blood pressure incident to spinal anesthesia has been accounted for in various ways by experimenters. Four groups of cases have furnished observations which seem significant:

- (1) Anesthetics limited to the perineum without use of ephedrin have depressed blood pressure none or less than 8 Mm.
- (2) Those for the upper abdomen, unless ephedrin is used, have produced a maximum drop.
- (3) Those extending to the upper cervical region show no greater drop.
- (4) In cases exhibiting temporary respiratory failure the blood pressure has been as well sustained.

The fall of blood pressure, therefore, can hardly be due simply to decreased respiratory movements; nor can it depend upon the toxicity of the drug systemically since the dosage has been constant. The drop does occur, however, whenever the anesthesia includes the upper abdomen, that is, when the segments from the ninth dorsal to the second lumbar are anesthetized. It is of interest that these roots are chosen for section in operations for essential hypertension as those whose division produces the greatest effect.

It is not apparent why pantocain depresses blood pressure less than procaine, yet this has been our experience and that of others who have reported. We

have noted that the collapse of the intestine is less. If this may be taken as an index of effect on sympathetic fibers, it may in part explain the lessened vasomotor effect.

The postoperative complications have been studied by comparing records of 1,651 cases done under procaine, 606 under pantocain and 1,198 under avertin. Shock attributed to the anesthetic was encountered with procaine 51 times, with avertin 12 times, but with pantocain only once. Headache of severe grade was recorded eight times with procaine while none is recorded against avertin or pantocain. However, pantocain is credited with two of mild degree. Catheterization followed 25.4 per cent of the procaine anesthetics, 21.4 per cent of the avertin, but only 2 per cent of the smaller pantocain series. Unexplained death at intervals of 3 to 42 days followed procaine once and pantocain twice. There have been several neurologic sequelae following procaine but none following pantocain. Spinal fluid cell counts done 24 hours after operation have shown no significant rises to suggest a local irritation by the drug. One case showed 85 cells—mostly lymphocytes, in the presence of a red cell count of 2,000. It was assumed that blood had been the irritant.

An important purpose in using spinal anesthesia has been avoidance of respiratory complications. In a series of 596 operations under neocaine, compared with a parallel series of 1,198 done under avertin-gas-oxygen, the gross incidence of postoperative pneumonia was 10.5 per cent *versus* 4.6 per cent in favor of avertin. The corresponding figure for pantocain was 4.5 per cent. In the neocaine series, however, 47.7 per cent had known anteoperative major or minor respiratory complications while the avertin series contained one-half this number. Excluding these, the figures are 1.67 per cent *versus* 2.3 per cent—a 37 per cent advantage for spinal. Again, in the presence of a minor anteoperative respiratory complication, pneumonia followed in 1.37 per cent spinal anesthesia cases against 8.2 per cent for avertin. In the face of a major anteoperative respiratory complication, spinal anesthesia showed no statistical superiority. Obviously, then, from the standpoint of pneumonia spinal anesthesia's special indication is the presence of a cold or sore throat. Of importance to us, however, were the figures when spinal anesthesia was supplemented with gas and oxygen. These showed no advantage for spinal, and again demonstrated strikingly the need for a drug giving a more prolonged effect.

Since these figures show a lower incidence of postoperative complications in most respects than procaine or avertin, we feel safe in saying that pantocain is well tolerated.

It is only fair to note that ephedrin should be credited with a certain share of the improved postoperative course seen after pantocain. In most cases procaine was given without ephedrin or the ephedrin was given subcutaneously or at too short an interval before the anesthetic. The unimportance of the immediate fall of blood pressure is not in accordance with our experience. The subjects showing the greatest depression of blood pressure have, as a group, shown complications in greater number and in greater severity. Nausea

and vomiting on the table are not the only sequelae due, in whole or in part, to this phenomenon.

However, pantocain has one very serious drawback. We have had 14 cases of respiratory failure, two of which were fatal. Procaine also has provided four, with two deaths, but in a series two and one-half times as large. The sequence of events in each case has been much the same, the picture being a progressive paralysis of the muscles of respiration. As the level of anesthesia rises intercostal paralysis takes place, the patient becoming without distress an abdominal breather. Spoken voice still remains. As the anesthesia begins to affect the phrenic nerves, abdominal breathing becomes lessened, the alae nasae begin to distend, and the voice is whispered. From here the picture advances quite rapidly, the accessory muscles of the neck are brought into full play, the head is moved to and fro, the chin begins to drop with each respiratory effort, the patient becomes unable to speak, although he can move his tongue, and finally there is a rolling of the eyes with loss of consciousness and dilation of the pupils with cyanosis.

Resuscitation has been accomplished with artificial respiration. With a tight fitting mask and a rebreathing bag containing oxygen and carbon dioxide under positive pressure, patients have been carried along for periods of 5 to 95 minutes, by alternately compressing and releasing the bag. The 12 patients who recovered showed no further ill effects.

We have no doubt that these accidents were caused by the induction of a level of anesthesia which was too high, and that one or more of the following technical errors was responsible in each case:

- (1) Administration of the drug with patient in sitting position.
- (2) Lowering the head of the table before the drug had been fixed.
- (3) Too great an amount or volume of the drug, too rapidly injected.

The first death was caused by an overdose and lowering the head. The patient was a short, obese woman of 46, whose thoracic spine was too short for a large volume of the drug and premature tilting of the table. Respiration began to fail 14 minutes after the injection, followed by circulatory collapse in five more.

The second death also was caused by too great a volume of anesthetic. A 31-year-old woman, tremendously distended by intestinal obstruction, was given a high anesthesia. The loss of the intercostals is little handicap to breathing ordinarily, but with the diaphragm already immobilized by distention it produced prompt respiratory failure followed by circulatory collapse.

There is some consolation in the fact that the accidents have not come to men with considerable experience in the use of pantocain and that a subsequent series of over 200 anesthetics have been given without a death. But two deaths, even in 800 cases, are two too many. In spite of this pantocain continues to be the anesthetic chosen by most of the staff when dealing with bad risks or shocking procedures.

Pantocain would be quite satisfactory if its administration could be consistently controlled so as to affect only the spinal roots selected for the operation

in question. A solution which would definitely favor the sensory roots and mix minimally with the spinal fluid appeals on theoretical grounds. We have been provided with a pantocain preparation of specific gravity 1.024. Its greater density assures sinking in any spinal fluid so as to puddle posteriorly and bathe the posterior roots. Its weight should also reduce to a safe level the tendency to mix with spinal fluid. Injected into the first lumbar space, for example, we would expect it to flow down the lower dorsal declivity and lie in the thoracic curve until completely taken up in the sensory roots with which it lies in contact. In the small series of anesthetics so accomplished it has seemed to justify our expectations.

On the whole we have found pantocain a satisfactory drug for spinal anesthesia. Its duration and lesser effect on blood pressure particularly recommend it. The present solution is not satisfactory for upper abdominal work in the hands of the inexperienced. "Heavy Pantocain" is a possible solution of our problem.

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DISCUSSION.—DR. CHARLES L. JANSSEN (New York) said that when novocain anesthesia was first used in the surgical treatment of carcinoma of the rectum by the abdominoperineal operation, it was thought to be a great improvement because with spinal anesthesia the abdominal stage of the operation was easier and more rapid. However, it was soon realized that in the length of time that novocain spinal anesthesia lasts, that is, one and one-half hours, it was frequently very difficult to do an operation as extensive as this in one stage. In 78 per cent of cases, it was necessary to supplement it with some general anesthesia. But with the advent of pantocain anesthesia, general anesthesia has been required, in addition, in only 25 per cent of cases, and in at least two of these it was not because the anesthesia had worn off but because the patients were excitable and complained of a great deal of pain in the shoulder region (as a result of the prolonged Trendelenburg position). In all cases operated upon under spinal anesthesia alone, whether novocain or pantocain, there has been no operative death. When general anesthesia has had to be combined with spinal anesthesia, especially with novocain anesthesia, the mortality has been as high as 31 per cent. In a group of 20 cases where pantocain has been used, including those requiring, in addition, general anesthesia, there has not been a death. In operative procedures which may require more than one hour, Doctor Janssen felt that pantocain as a spinal anesthesia is much more satisfactory than novocain.

DR. HENRY F. GRAHAM (Brooklyn) stated that, although not an anesthetist, he had given approximately 1,000 spinal anesthetics, including at first novocain and more recently one or two hundred pantocain anesthetics. As a result of the exercise of great caution in administering the anesthesia with a somewhat larger percentage of incomplete anesthesia than usual, no deaths had resulted to date. He concurred in the observation that pantocain is much more satisfactory than novocain.

Regarding the cause of death in spinal anesthesia, reference was made to the conclusions of Bower, Clark, Wagoner and Burns in an article in *Surgery, Gynecology and Obstetrics*, June, 1932. They summarized the clinical and experimental work in spinal anesthesia for a period of 11 years and concluded that death from spinal anesthesia was the result of the following series of events:

- (1) Drug paralysis of cardiac and respiratory nerves, including the phrenic and intercostal nerves;
- (2) Dilatation of the heart and respiratory embarrassment;
- (3) Cardiac dilatation and venous stasis in the great veins of the thorax and a later drop in arterial pressure;
- (4) Anoxemia caused by the fall in arterial pressure and diminished respiration;
- (5) Death.

These authors also found that, in general, artificial respiration was the only stimulation necessary to effect recovery, provided it was begun before the respiratory center had ceased to function and was continued long enough.

After hearing the work of these authors described, in 1930, he had an old pulmotor overhauled, including the installation of complete new tubing, removing the regular pulmotor tank because it was of an odd size and adapting the machine to regular small oxygen tanks for instant availability. This was kept in the anesthetizing room, adjacent to the operating room. Four years passed during which many hundreds of anesthetics were given without the necessity of using the pulmotor. Four months ago after injecting 18 mg. of pantocain under the third lumbar spine, the patient upon whom a hysterectomy was to be done stopped breathing. A suture was immediately passed through her tongue and within 60 seconds the pulmotor was placed over her face. The patient improved at once. Her pulse became strong. The hysterectomy was completed, and at its conclusion the pulmotor was removed, whereupon normal respirations commenced spontaneously.

In his opinion, the theory of the cause of death advanced by Bower, Clark, Wagoner and Burns is correct. Moreover, the instantaneous use of forced artificial respiration to reestablish the pumping action of the diaphragm will generally prevent spinal anesthesia death.

DR. CALDWELL B. ESSELSTYN (New York) said that during the past year pantocain was used in Presbyterian Hospital in 85 per cent of operations on the pancreas, 92 per cent of abdominoperineal resections, 84 per cent of spleens, 67 per cent biliary tract, 72 per cent intestinal resection exclusive of abdominoperineal resections, and in 82 per cent of the stomachs. The differences between pantocain and novocain are very real, profoundly influencing administration. First with regard to duration: In novocain the maximum duration is probably with 10 per cent solution, that is 100 mg. of novocain mixed with 1 cc. spinal fluid, or 200 mg. with 2 cc. given without barbitage. On the other hand, greater dilution does not divide the time proportionately. But if pantocain is diluted with an equal amount of spinal fluid, there is anesthesia for one and one-half to two hours, whereas if given undiluted without barbitage, it may run up to four or five hours. Halving the dilution practically doubles the duration of the anesthesia. Secondly, with regard to fixation: Novocain becomes fixed in the cord in a period of 10 or 15 minutes, after which time changing the position of the patient makes no difference in the fixation of the drug. In pantocain, however, fixation takes at least 20 to 25 minutes.

Its effect on the sympathetic nervous system is generally that it does not

drop blood pressure as much as does novocain; collapse of the bowel is not so profound, and those operated upon under pantocain have had to be catheterized in only one-twelfth the percentage of cases of those operated under novocain in spite of the major surgery which has been done under pantocain.

Pantocain can be given much more accurately than novocain, and because of this is especially desirable for certain operations. For instance, on the rectum, where 0.5 cc. or 0.75 cc. injected into the fifth lumbar interspace without barbitage, will produce spinal anesthesia limited to the perineum which will last four or five hours, without any drop in blood pressure. In producing anesthesia for inguinal herniorrhaphy the best results with pantocain are obtained when the tap is made opposite the nerve roots to be blocked. These are the eleventh and twelfth dorsal and upper second lumbar nerve roots. Therefore, the site of the tap should not be in the commonly selected third and fourth lumbar, but in the twelfth dorsal interspace or first lumbar at the lowest. In this way 1.5 cc. of pantocain, again given slowly and without barbitage, or 1 cc. of the drug diluted with 0.5 cc. of spinal fluid given similarly, will give the longest duration of anesthesia involving the operative field—the maximum length of postoperative comfort and the minimal physiologic disturbance to the patient.

It is in the upper abdominal operations that the most trouble is encountered. Although there are two types of abdominal operations allowing a comfortable incision up to the ensiform, but in one of these groups traction on the mesenteries gives no distress, while in the other it causes retching and vomiting. Study has shown that where anesthesia extended to the level of D1-D2, apparently there was traction without disturbance. So with pantocain the effort is made to stand way back at the twelfth dorsal or the first lumbar interspace and run the anesthesia up to D1 or D2 without any more control over it than the technic with which it is primarily given. The difficulty has come from the fact that the specific gravity of pantocain has been almost that of the spinal fluid, limiting thereby an intelligent control of the anesthetic by posture. Doctor Esselstyn had found a solution furnished by Dr. Hans Clark of help, but since a drug with a higher specific gravity is definitely of advantage in the upper abdomen, he had been using pantocain of a specific gravity of 1.024.

When given slowly pantocain does not diffuse to an appreciable degree; as evidenced by cell counts or lumbar taps 24 hours after it has been used, it is not irritating to the cord or cord membranes. Finally, by changing posture it has been possible to control the level of anesthesia in all cases. Using the solution mentioned, pantocain has proved safe for the upper abdomen if the patient remains level, and if the head from the lower cervical region up is put in a fairly marked cockup position. Furthermore, the anesthesia in this instance gravitates to the thoracic curve, giving the maximum amount of the drug opposite the nerves supplying the operative field.

It is felt that when spinal anesthesia is indicated, pantocain is the drug of choice; that the present stock preparations are satisfactory for lower abdominal but dangerous for upper abdominal work and that a solution of heavy pantocain is both safe and satisfactory for upper abdominal anesthesia.

DOCTOR BULL.—In answer to Dr. Erdman's question there certainly is a strong prejudice against the use of spinal anesthesia where the blood pressure is very high or very low. Our series includes cases of each type. Low pressures have been raised to reasonable levels and success-

fully maintained by infusion plus ephedrin. Fluctuations of blood pressure in hypertensives have been minimized by use of ephedrin. We have been much more courageous since adopting the improved technic in ephedrin administration. King, of Philadelphia, in the February issue of the *ANNALS OF SURGERY*, 1935, describes a measurement of cardiac reserve by means of a test dose of ephedrin on which he depends to prevent surprises. He also notes that in the presence of an apparent contra-indication to the use of spinal anesthesia it is often the anesthetic of choice, as inhalation anesthesia has even less to recommend it in some of these bad risks.

CARBON DIOXIDE ABSORPTION TECHNIC IN ANESTHESIA*

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APPRECIATION of the function of the lungs and the true physiology of respiration, which had for its foundation the discoveries of Priestley, Lavoisier and others late in the eighteenth century, opened the door for the introduction of inhalation anesthesia.

Over 100 years elapsed, however, before a complete understanding was current of all the changes that take place in the atmosphere during its entrance into and exit from the lungs. Oxygen was known to be lost while air was in the lungs and carbon dioxide to be picked up. The reason for the bad effect of "stale" air was not clear. In 1842, Leblanc studied the air of crowded assemblies and found that it contained 20 per cent oxygen. In 1849, Regnault and Reiset found by experimentation that oxygen in the inspired atmosphere could be reduced to 10 per cent before respiration was seriously embarrassed and that carbon dioxide decidedly in excess of the concentration found in overcrowded rooms was necessary to produce marked effect. The theoretical explanation then became current that "stale" atmosphere was poisonous because of the presence in the expired air of "poisonous volatile organic matter, probably protein in nature." Dubois Reymond gave this supposed substance the name "Anthropotoxin."

The existence of anthropotoxin was generally admitted until the twentieth century. Haldane, Flugler, Leonard Hill and others presented evidence against such a theory early in the century but in this country it remained for the New York State Commission on Ventilation to convince sanitary engineers as well as the medical profession of the mythical existence of anthropotoxin. Many reports of the Commission may be found in the literature following 1912. Their conclusions were that the air of crowded rooms was intolerable through the accumulation of heat and moisture and lack of movement, and not from the presence of anthropotoxin in the expired air.

The construction of inhalers for the vaporization and administration of anesthetic agents, from the discovery of anesthesia up to 1900, necessarily took into consideration the supposed existence of the fictitious toxin. The first ones, constructed by Morton in this country and Snow in Great Britain, aimed simply at delivering to the patient's air passages a vapor laden air which passed to the lungs and thence by a one-way valve to the room atmosphere. It was soon found that simple dropping of the volatile agent upon cloth held over the nose and mouth served the purpose. Vaporization in either manner necessitated the use of large quantities of the drug. In process

* Read before the New York Surgical Society, March 13, 1935.

of vaporization, heat was used and therefore a very cold atmosphere was inhaled, leading to irritation of the membranes and other undesirable effects. Control of dosage and management of resistant cases was difficult by these technics. Attempted improvements were represented in Great Britain by the Clover inhaler (1876) and its long series of modifications, and in this country by such inhalers as the Bennett and its modification by Coburn, Gwathmey and many others. Appreciation of the handicap of the cloth vaporizers was apparent in the development of inhalers such as the Ferguson, the Allis or the handkerchief cylinder and cone. In each of these a wall, surrounding the vaporizing surface tended to enclose and retain some of the expired atmosphere, and with it otherwise wasted anesthetic vapor, together with heat, moisture and carbon dioxide of the exhaled air. Both types of attempt at semi-closed inhalation of anesthetic vapors, the rubber bag and the wall surrounding the face and vaporizing surface resulted in some advantage and at the same time disadvantage. Advantage was evident in better control of dosage and saving in quantity of agent, together with a warm moist vehicle in which to inhale the anesthetic vapor. The disadvantage lay in a decided increase in breathing due to the accumulated carbon dioxide, and more important, a reduction in the oxygen content of the atmosphere inhaled. The disadvantage of oxygen deprivation so much outweighed the advantages of semiclosed methods that a return was made in many quarters to "open drop" technic with or without morphine premedication. "Open drop" was advocated by Prince about 1894 and the method came into common use in many large clinics. In European literature, the technic of Prince has been erroneously referred to as the Mayo technic. When oxygen became available, either compressed in high pressure cylinders or from oxygen generators, the addition of this gas through semiclosed inhalers of the Clover and Bennett type was commonly employed. Such inhalers with oxygen were utilized for the continuous administration of nitrous oxide gas as well as of volatile liquids. Even so, the temptation was always present to take advantage to the full of economy of agent, heat and moisture at the risk of too much carbon dioxide being reinhaled.

Early in this century, Haldane, Hill and Flack, Henderson and others studied the problem of carbon dioxide in respiratory atmospheres. Gatch applied their findings to the problems of anesthesia. He studied and practiced the rebreathing of anesthetic atmospheres, calling attention to the advantages of excess carbon dioxide and to its disadvantages. He appreciated the value of the warming effect of reinhalation.

In the year 1916, the following conditions obtained in regard to inhalation anesthesia.

(1) A completely open technic was known to result in a cold dry atmosphere being inhaled, resulting in irritation of membranes and resultant hyperactive breathing. Control of some patients was difficult or impossible. It

had also been noted that excess loss of carbon dioxide with such technic sometimes caused circulatory depression (ether shock).

(2) A semiclosed technic was as a rule less damaging to the patient but required much clinical judgment in its use. Respiratory movements were excessive due to retained carbon dioxide. Cost of gas anesthesia, though less than with completely open technic, was for many cases prohibitive.

(3) With all inhalation anesthesia, sweating was the rule, reduction of body temperature usual, annoyingly hyperactive breathing frequent, and operating teams were constantly exposed to high concentrations of agents used.

In 1916 Dennis Jackson of the University of Cincinnati demonstrated that by absorbing expired carbon dioxide in alkali, animals could be confined indefinitely in a closed space containing an anesthetic mixture. The only necessary addition to the mixture was, he found, sufficient oxygen from minute to minute to replace that used out of the mixture as it diffused into the blood from the animal's alveoli. He determined that there was no oxidation of the common anesthetic agents while in the body and practically no excretion, other than through the lungs. Jackson thus called attention to a fact which, when applied to clinical anesthesia, was destined to eliminate many of the unphysiologic side actions previously considered necessary accompaniments of inhalation anesthesia. With a completely closed respiratory system and the absorption of carbon dioxide, the vapor of agents such as ether could be inhaled in a warm and moist atmosphere. The body temperature of patients subjected to long periods of anesthesia need no longer be expected to become depressed. Irritation and stimulation of the respiratory tract was less, resulting in quiet breathing during operation. Reflex stimulation of perspiration from cold inhalations was less frequently seen, which, taken together with the maintenance of a completely moist atmosphere for inhalation, resulted in considerable reduction in invisible water loss during and following operations. Quieter respiratory activity resulted in a decreased amount of work being performed during anesthesia. With the resultant decreased demand for oxygen, a greater margin of safety was made available in anesthesia with certain gases. The technical difficulties of administration were, in the main, simplified. The quantity of anesthetic agents used was greatly reduced. The anesthetist no longer need choose one anesthetic agent for private patients and another for ward cases on the ground of a difference in cost. The atmosphere of operating rooms was no longer saturated with anesthetic gases and vapors. Fire and explosion hazards were thus greatly reduced and surgical teams found themselves free of the chronic effects of ether and other drugs.

Clinical Application.—The clinical application of Jackson's principle of carbon dioxide absorption is now being utilized by every manufacturer of anesthesia apparatus in this country. The mechanical details have varied. Early development of the technic was dependent on the availability of a

safe and efficient absorbing agent. Jackson's original experiments were done with sodium hydroxide sticks. Fortunately, at the close of the World War, Wilson was conducting experiments for the United States government in an attempt to produce an efficient absorber for use in gas masks. The result of these experiments, known as "Wilson's Soda Lime," has so far proved the most applicable to the needs of anesthesia. "Wilson's Soda Lime" consists of a mixture of calcium and sodium hydrate and a small addition of Kieselguhr in such proportions as to result, when properly prepared, in a granular material which does not deliquesce on exposure to exhaled air. The alkaline content does not go into solution in water of condensation. Some heat results from chemical reaction of the carbon dioxide with the alkali. Some water is absorbed by the soda lime. Gradual improvement in making soda lime more perfect has taken place since Wilson's work in 1921 and the manufacturers are engaged in further experiments in the hope of producing an absorbing agent with minimum bulk, dust content and heat production, with maximum capacity for absorption of carbon dioxide and maintenance of the most physiologic humidity of the inspired atmosphere. Two widely different mechanical solutions of the construction of a closed respiratory system are obvious.

Closed Respiratory Systems.—First, one may use a circle device in which the expired atmosphere is carried from a face mask through tubing leading to the absorber, thence to a breathing bag or spirometer and thence back through tubing to the mask. Somewhere along this circuit, an inlet is provided for the original filling of the system with anesthetic mixture and the constant addition of oxygen to replace that used from the mixture by the metabolic activity of the patient. This is the mechanical construction of apparatus for the determination of oxygen consumption from which metabolic rate is estimated. Although the construction of metabolism apparatus has, in many instances, depended on one-way valves for the assurance of the circulation of the respired atmosphere, in every case the manufacturer has eventually resorted to the use of an electric fan or pump to maintain circulation without effort on the part of the patient.

My own early experiments were attempts to reach a mechanical solution of carbon dioxide absorption in anesthesia in this manner. The difficulty of eliminating leaks under operating room conditions, the "load" to respiration of forcing atmosphere through tubing and one-way valves, and the undesirability of including an electric fan or pump when ether vapor and other explosive agents must be employed, led to its abandonment for routine operating use.

The second mechanical solution of a closed respiratory system, a direct or to-and-fro application, although it has not been applied to metabolism apparatus, has proved most satisfactory in our hands for use under operating room conditions in anesthesia. The arrangement is as follows: A canister of soda lime granules (4 to 8 mesh) contained in a cylinder (8 by 12 cm. inside dimension) is inserted between a face mask and small rubber breath-

ing bag (ten inch). Contact is made with mask and bag by means of metal tubing (2.8 cm. in diameter) in the form of easily connected and disconnected slip joints. The granules are held in place in the cylinder by means of a wire gauze dam at each end. A nipple is provided in the mask through which the closed respiratory system is filled during induction of anesthesia, and a constant measured flow of oxygen maintained at a rate of 200 to 400 cc. per minute throughout the administration. Since there is at present a likelihood that even the best soda lime may contain dust, forceful blowing through the canister before attaching it is essential until all dust is expelled. The use of a full size bed pillow for the patient is essential. Thus provided, and with the patient's head slightly turned to the right, the lower end of the canister rests on the pillow as the mask is fitted to the face, the bag extending over the end of the pillow and the side of the operating table. The presence of the breathing bag in the immediate vicinity of the head is considered a safety factor. It is readily visible and available for artificial respiration in an emergency. If excess carbon dioxide in the anesthetic atmosphere is indicated, the canister may be omitted, the slip joints serving to connect mask to bag directly. Rarely do we find the addition of carbon dioxide to anesthetic mixtures to be advisable during maintenance. The bag and mask without soda lime are, however, often used to hasten induction time with ether and to facilitate intubation for endotracheal anesthesia. We believe that the addition of carbon dioxide to anesthetic mixtures in open and semiclosed technics, the excessive employment of rebreathing, and the ill advised use of soda lime "cut outs" in closed technics have frequently resulted in physiologic damage and even fatality.

The everyday management of such a closed technic in the operating room has not been found arduous. An elastic retaining harness has proved useful in aiding the anesthetist's hand to maintain airtight contact of face and mask. Care must be taken to check breathing bags and apparatus periodically for leaks. The anesthetist should have a clear appreciation of the physiologic signs of oxygen want, carbon dioxide excess and overdose of the agents used. Frequent blood pressure readings are taken. A rising systolic pressure, not explainable on other grounds, and a gradually increasing hyperpnea give evidence of accumulating carbon dioxide, usually indicating that the absorptive property of the soda lime is becoming depleted. A canister of the size described above lasts usually not less than seven hours.

For work about the face and head, plastic and brain surgery, closed endotracheal airways are often substituted for the face mask, an adapter serving to connect the airway directly to the soda lime canister. Specially shaped masks are useful for certain operations. Holders for canisters in positions precluding the presence of the anesthetist in the vicinity of the head are shown. To make such positions safe, previous intubation should be done to avoid all danger of obstruction to the airway. The ease with which an anesthetized patient can be moved from one room to another should be noted. A quick addition of several hundred cc. of oxygen and the delivery tube may

ANESTHESIA

be disconnected from the mask. Several minutes' interval may then safely intervene before connecting to the machine in another operating room.

Clinical Experience.—More than 15,000 administrations have been conducted with the completely closed or carbon dioxide absorption technic by my associates and myself. We have found it pleasant and convenient from the standpoint of anesthetist, patient, and surgeon. The hospital management has found it economical. In Tables I and II may be seen the percentage of postoperative morbidity and mortality at Wisconsin General Hospital for the years 1933 and 1934. 73.8 per cent of these cases were done with various agents administered by the carbon dioxide absorption technic.

TABLE I
Postoperative Morbidity

		Per Cent of Cases
Total cases (1933-1934).....	7,996	
Absorption technic.....	5,903	73.8
Respiratory:		
Major.....		1.2
Minor only.....		4.7
Circulatory.....		9.1
No nausea or emesis.....		70.3

We find the teaching of the underlying principles of anesthesia to be easier when using this technic than when older methods are employed. The student or intern without supervision may accomplish acceptable anesthesia somewhat sooner with open drop ether. However, with reasonably careful supervision, we are able to help senior students, serving a week in anesthesia, to do acceptable work with the absorption technic.

TABLE II
Postoperative Mortality

		Per Cent of Cases
Total cases (1933-1934).....	7,996	
Absorption technic.....	5,903	73.8
Total deaths.....	294	3.7
Respiratory causes.....		0.6
Circulatory causes.....		0.9
Anesthesia.....		0.05
Other causes.....		2.1

TIME OF DEATH

Oper. Day	1-3 Days P.O.	4-7 Days P.O.	2nd Week	Later
6.5%	17.7%	18.0%	16.2%	41.5%

The acquisition of a mastery of anesthesia in art and in practice, with a thorough appreciation of the underlying physiology and pharmacology, in-

volves for the average medical graduate an intensive training of not less than three years. We thoroughly believe that the knowledge and skill of the individual who administers an anesthetic drug is far more important than is the agent which he administers or the technic by which he administers it. The following statement was made by a prominent surgeon in regard to the care of brain injuries. "Changes in the patient's condition frequently appear so quickly and the period in which favorable action is possible is so brief that life may truly hang by a slender thread, the breaking or strengthening of which is dependent on the quality of the physician's care and skill. By quality is not necessarily meant specialists, but experts—those using the best clinical judgement (which is usually indicated by common sense) and the best technical ability." A patient with a brain injury enters the average hospital once in 20 days, whereas 20 patients in the average hospital have their brains and many other organs injured every day with anesthesia. When I first read the above quotation, it seemed to me that Walter Dandy must have been speaking of anesthesia.

Please do not therefore get the impression that the chemical absorption of carbon dioxide from anesthetic mixtures will revolutionize anesthesia. Only "the quality of the physician's care and skill" will do that.

DISCUSSION.—DR. JAMES T. GWATHMEY (New York) expressed the understanding that the fundamental idea of absorption technic is to keep intact the physiologic balance between respiration and circulation. But, he thought, the only way to approach this with an inhalation anesthetic is by means of preliminary medication in such a way that the patient is either unconscious or nearly so when brought to the operating table, terminal anesthesia—whatever it might be—being a supplementary measure. Very few institutions do this, however, although Willard Bartlett has been quite severely criticized for giving patients 15 gr. of luminal and morphine sulphate $\frac{1}{4}$ gr., so that they are asleep when they come to the operating table. This medication, however, quiets the patient for four, five or six hours after operation, and allows the tissues to react so as to bring the patient out in a completely analgesic state.

By preliminary medication the same effect is achieved as with carbon dioxide absorption, and without additional apparatus. But if increased relaxation—so desired by all surgeons in addition to safety—is better obtained with the absorption technic than without it, then this technic will be used by all whenever inhalation anesthesia is indicated. The only inhalant anesthesia, in Doctor Gwathmey's opinion, that keeps normal the balance between respiration and circulation is a new one, namely, cyclopropane. Since it does not seem to touch the respiratory center at all, it must certainly have a definite place in the future. Full credit, Doctor Gwathmey said, for the development of both cyclopropane and the absorption technic must go to Doctor Waters.

DR. E. A. ROVENSTINE (New York) thought that one advantage of the absorption technic which had not been brought out by Doctor Waters was its definite effect on respirations. Surgeons with considerable experience agree that in this type of anesthesia the respirations are more quiet and the degree of relaxation is as much as with other technics, giving the added advantage that the quiet abdomen offers in making operative conditions more nearly ideal.

DOCTOR WATERS (Madison, Wis.) called attention to the fact that one of the difficulties with open technic has always been the irritation of the cold vapor. The irritation of such drugs as ether is very much less when inhaled in a warm than in a cold atmosphere. The phenomenon of sweating after a cold drink of water taken on a hot summer day when one is not sweating may be a reflex sympathetic stimulus, but the same phenomenon occurs with inhalation in a closed system. The patients almost never sweat but remain dry to an extent that is impossible with open technics of inhalation. There is quieter respiration, as a rule, with the absorptive technic, possibly secondary to the warm atmosphere, and this results in a lessened use of oxygen, lessened muscular work, and, due to the lesser use of oxygen, provides a little more margin.

The advantage of premedication is to reduce the consumption of oxygen. Invisible water loss through the respiratory tract must be less with a constantly inhaled, completely moist atmosphere. This, combined with the lack of sweating and the almost complete elimination of the loss of water through the lungs, conserves water to a considerable degree.

In developing the absorption technic the quest was not simply to save money. The relative cost of anesthesia is not more important than the difference between a 20 and a 50 cent tube of catgut for the surgeon; results are essential. Certain agents should not be eliminated because they cost more. However, the necessity of deciding at times whether one should give a patient one anesthetic agent or another on the basis of cost is done away with entirely by the absorption technic.

The technical difficulties of the absorption technic are not very great; on the contrary, at the end of a month, during which it has been taught to the interns, better work is done by them with this method than with the open technic.

Additional advantages of the method are that it requires less care regarding the danger of fire and explosion, and, finally, it not only protects the operative team from anesthesia vapors, but eliminates the clinging odor of ether that is prevalent when one works all day by the open method.

Doctor Waters concurred with Doctor Gwathmey regarding premedication except that he felt it might be overdone. All nonvolatile agents when injected for premedication, he said, may cause respiratory depression and oxygen want. Hence it is best to stay at a safe dosage of premedication and add sufficient inhalation anesthesia, which is absolutely controllable.

PREANESTHESIA NARCOSIS WITH PARALDEHYDE*

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DURING the past eight months we have been interested in the development of some form of efficient preanesthesia narcosis which would be simple to administer, possess the greatest possible margin of safety, have a relatively transient effect upon the patient and be inexpensive.

We have, upon various occasions, achieved more or less satisfactory narcosis with sodium amytal, sodium phenobarbital, or tribromethanol. These drugs, though of unquestionable value in certain instances, have inherent drawbacks which make them undesirable for general use. The margin of safety of none of these drugs is very great, and their use is frequently attended by undesirable side reactions. Tribromethanol requires preparation by one with specialized knowledge, and demands a very definite technic in its administration. Moreover it is expensive.

With these things in mind, Dr. Chas. Gordon Heyd suggested the rectal administration of paraldehyde as a possible answer to these difficulties. Paraldehyde was introduced by Cervello in 1882, and has recently appeared in the literature as an obstetric analgesic, always coupled with sodium phenobarbital or sodium amytal. It is a polymer of acetic aldehyde, colorless, and has a characteristic pungent odor. It is soluble in water, miscible in certain oils, and possesses similar pharmacologic actions to alcohol, except for a marked accentuation of the hypnotic effect. One of the most desirable features of this hypnotic is its remarkable safety factor. Whereas the average dose is in the neighborhood of 20 to 25 cc., 100 cc. have been administered without serious effect other than the production of a prolonged sleep.

Over a series of some 50 odd unselected cases, the technic of administration has been developed as follows: The patient is weighed on admission to the hospital, and has usually been on bed rest for a varying period of time prior to operation. The night before operation the patient is given a cleansing soap suds enema, seldom a cathartic. One to one and one-half hours before operation the patient is turned upon his left side and the mixture containing about two tablespoonfuls of starch to a pint of water, to which has been added the requisite amount of paraldehyde is administered. This has been found empirically to be about 0.15 cc. per pound of body weight, although the dose may be varied within wide limits according to circumstances. Starch solution is used as the vehicle, because absorption of the paraldehyde from this solution is satisfactory, and it is more easily retained by the patient than oil. The total amount instilled into the rectum should not exceed six ounces, as patients are prone to expel larger quantities. One-

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half hour prior to the scheduled operating time, the patient is given a sixth of a grain of morphine, and 1/150 of a grain of atropine or scopolamine, depending upon the nature of the selected inhalant. This entire routine is carried out on the ward by the nurse in charge of the patient.

Approximately 15 minutes after the administration the patient falls into what is to all intents and purposes a quiet, natural sleep. He may occasionally appear to be awake, and may even give a more or less rational answer to a simple question if aroused, but on complete recovery he retains no memory of this, and shows in about 95 per cent of the cases a very satisfactory and desirable amnesia for all events subsequent to the instillation of the drug.

The patient's face is usually slightly moist and flushed; there may be either slight mydriasis or miosis, but the corneal and light reflexes are retained. Respirations are not affected except that they are quieter and more shallow, as in sleep. The blood pressure may show either a slight rise or fall, depending largely, we think, upon the previous psychic state of the patient. There is often a slight rise in the diastolic pressure, especially in thyroid cases. There is no marked diminution of the general bodily reflexes.

As a rule, these patients take an inhalation anesthetic well. The respiratory rate is generally slightly increased under the irritation of the inspired ether, as well as by the trauma of the operation. It should be noted, however, that if the preoperative morphine is given less than a half hour before operation, there is a depression of respiration by this drug on attempting to induce anesthesia; this is not a concomitant of the paraldehyde hypnosis. It is estimated, without any accurate quantitative determinations, that satisfactory anesthesia is obtained on approximately half the usual volume of the inhalation agent, be it either nitrous oxide or ethylene.

Recovery occurs two and one-half to four hours after administration, depending upon the amount given, and the nature and depth of the supplementary anesthetic. Paraldehyde is particularly advantageous for use with thyroid cases. The extreme hyperkinesis with which most of these patients come to surgery yields readily to this drug, and they are relieved of the apprehension and fear which they usually experience. Moreover, we feel that it is desirable for these patients to react shortly after the operation, so that the nature of the voice sounds may be ascertained before possible impairment by postoperative edema occurs. With proper timing and dosage, it is possible to arouse the patient sufficiently to have him speak a word immediately after leaving the operating room, although he does not remember this, and promptly falls asleep again.

With the use of paraldehyde we have noted no increased tendency toward operative bleeding, nor have there been any noteworthy postoperative complications in this series. Occasionally there is an increased postoperative restlessness, but this is easily controlled by morphine or one of the barbiturates.

The contra-indications are those of any general anesthetic. Paraldehyde

is excreted largely by the lungs, and may be noticed on the breath for about 24 hours after operation, but this is not unduly offensive. We feel that this drug should not be used in the face of hepatic or renal disease, colonic or rectal pathology, or parenchymatous lung affections.

PREOPERATIVE NARCOSIS WITH PARALDEHYDE
Condensed Chart Showing Relative Average Values

Average	Thyroids	Laparotomies	Miscellaneous
Age.....	39.2	44.2	44.2
Weight.....	136.7	135.7	123.0
B. M. R.....	25.1	—	—
Dose per lb.....	0.15 cc.	0.17 cc.	0.16 cc.
Total dose.....	23.9 cc.	22.8 cc.	21.2 cc.
Duration.....	2 hrs., 50 min.	3 hrs., 36 min.	3 hrs., 42 min.
B. P. a. Nar.....	152/73	132/84	138/92
B. P. p. Nar.....	142/82	122/81	120/82
Var. in resp.....	21	21	20
Amnesia.....	93%	92%	100%
Restlessness.....	2%	2.3%	2%
Inhalant.....	Ethylene	Nitrous oxide-ether	Ethylene nitrous oxide-ether

Our experience has been that this is an excellent agent for allaying the severe, though often unappreciated, psychic trauma attendant upon the anticipation of any surgical procedure. It is simple to administer, of very low toxicity, and as nearly foolproof as anything of this nature can be. It is inexpensive, and requires no elaborate testing, preparation, or apparatus for its administration. Pharmacologically it is satisfactory as a means of providing basal narcosis, and can be used as a preliminary in practically any case in which a general anesthetic is indicated.

SIMPLE DERMOID CYSTS OF THE BREAST

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THE term simple dermoid cyst is used to designate the epithelial lined cyst which occurs in the dermal and deeper tissues of the breast. In other localities, the term is sometimes used to describe tumors originating from incomplete closure of prenatal lines of cleavage which give rise to such complicated tumors that they are sometimes mistaken for teratomas. These complicated dermoids are most frequently seen in the regions of the neck and the coccyx.

The present study was made from 36 cases of dermoid cysts collected in approximately 3,000 breast lesions. The first case was recorded in December, 1900, and because many of the new as well as the old cases contained incomplete histories and microscopic sections, the statistics offered may be criticized as being inaccurate. However, the statistics were formulated from the complete cases alone and the percentages figured from such cases.

TABLE I

Cases: 36

Universal Symptom: Tumor

Benign		Malignant	
29 cases (81 per cent)		7 cases (19 per cent)	
(1) Average duration.....	3.9 yrs.	(1) Average duration.....	2.3 yrs.
(2) Average age incidence.....	47.7 yrs.	(2) Average age incidence.....	54 yrs.
(3) Sex distribution:		(3) Sex distribution:	
Female.....	100 %	Female.....	100 %
(4) Single cyst.....	73.1 %	(4) Cyst formation.....	42.9 %
(5) Multiple cysts.....	6.89 %	(5) Location:	
(6) Location:		Left breast.....	85.7 %
Right breast.....	40 %	Right breast.....	14.3 %
Left breast.....	60 %	(6) Dermoid	
(7) Dermoid cyst		(sole pathology).....	72 %
(sole pathology).....	45 %	(7) Dermoid plus benign breast	
(8) Dermoid cyst incidental to		pathology.....	14 %
malignant lesion.....	18.2 %	Plus malignant breast	
Incidental to benign le-		pathology.....	14 %
sion.....	36.8 %	(8) Infected dermoid.....	29.5 %
(9) Infected dermoid cyst.....	27.6 %	(9) Giant cells with dermoid ..	0
(10) Giant cells with dermoid		(10) Result: Two of seven cases	
cyst.....	20.7 %	dead: one from metas-	
(11) Result: No recurrence or		tasis, and the other	
malignant change		from unknown cause	

TABLE II
Synopsis of Case Records

Path. Number	Race, Sex and Age	Duration	Benign or Malignant	Clinical Impression	Location	Symptoms	Operation: Date	Result	Last Menstrual Period	Microscopic
49839	W. F. 40	6 mos.	Benign		Left breast	Trauma, pain, tumor	Excision tumor, 6-23-31	Well, 4-21-32		Cysts (multiple), mature squamous-cell lining, keratin, leukocytic and lymphoid infiltration
45962	W. F. 73	3 yrs.	Benign	Dermoid	Right breast, lower quadrant	Tumor	Excision tumor, 9-0-31	Lost		Cyst, immature squamous-cell lining, keratin
44858	W. F. 49	10 dys.	Benign		Left breast, left upper quadrant	Irritation, small tumor	Excision tumor, 4-2-31	Lost	2 wks. previous to operation	Cyst, squamous-cell lining
44997	C. F. 47				Left breast	Tumor	Amputation breast, 9-29-28	Lost		Cyst (multiple), mature squamous-cell lining, keratin
40856	F. 2 dys.				Left breast	Pain	Excision tumor, 9-15-28	Well, 4-7-30		Cyst, squamous-cell lining, infiltration of leukocytes and giant cells
40640	W. F. 54	1 yr.	Benign	Infected dermoid cyst	Left breast, right lower quadrant	Tumor, pain, irritation	Excision tumor (cautery) 7-3-28	Well, 9-10-28	Menopause	Cyst, squamous-cell lining, infiltration of leukocytes and giant cells
40316	F. 57	2½ mos.	Benign	Dermoid	Tumor (gradual growth), pain		Excision tumor, 3-27-28	Lost		Cyst, squamous-cell lining
39674	F. 18 mos.		Benign	Keloid			Excision tumor, 12-0-27	Lost		Cyst, squamous-cell lining, infiltration of leukocytes and giant cells
38686	F.						Excision tumor, 12-20-26	Well, 10-28-29		Cyst, squamous-cell lining, infiltration of leukocytes and giant cells
36998	F.				Left breast	Tumor	Excision breast, 8-17-25 Excision malignant dermoid of abdominal wall	Lost		Cyst, squamous-cell lining
*35934	W. F.	1 mo.			Left breast, lower quadrant	Abscess, tumor	Excision tumor, 10-13-24	Well, 8-16-30		Cyst, malignant squamous-cell lining (multiple), keratin, lymphoid and leukocytic infiltration
35496	F. 47	3 yrs.	Benign	Dermoid	Left breast, upper quadrant		Excision tumor, 6-16-24	Well, 9-15-27		Cyst, squamous-cell lining, infiltration of leukocytes and giant cells
34496	F. 53	1½ da.?	Malignant	Carcinoma		Pigmented, warty mole, tumor (adherent and dangling) pedunculate	Excision tumor, 1-7-24 (complete)	Well, 11-4-27	Menopause 8 yrs. ago	Cyst, squamous-cell lining
*32515	F.						Excision tumor, 7-15-22 (complete)	Well, 1-11-28		Malignant squamous-cell lining (cyst formation)
32369	W. F. 53	5 yrs.			Right breast, upper, outer quadrant	Small firm mass, painless	Excision tumor, complete	Well, 1-0-28	Menopause at age 53	Cyst, squamous-cell lining (immature), keratin
31752	F.				Left breast			Lost		Cyst, squamous-cell lining

DERMOID CYSTS OF BREAST

30605	W. F. 43	4 yrs.	Benign	Left breast	Tumor, abscess incised, sinus	Excision tumor, 6-8-22	Well, 8-9-30	Present time	Cyst, mature squamous-cell lining
28945	C. F. 48	1 yr.	Benign	Right breast, areolar zone	Lump, pain, sinus	Excision tumor, 9-30-21	Lost		Cyst, mature squamous-cell lining keratin
28606	F.		Benign	Left breast	Tumor, pain	Excision tumor, 17-13-22	Lost		Cyst, squamous-cell lining
27580	W. F. 35	5 yrs.	Benign	Left areolar zone, lower border	Small lump, tenderness	Excision tumor, 2-9-21	Lost		Cyst, mature squamous-cell lining, keratin, grumous contents, infiltration of leukocytes
*26149	W. F. 60	5 wks.	Dermoid	Left breast, right lower quadrant	Tumor, pain	Incision, biopsy, amputation breast (radical), 5-20-12	Well, 1928	Menopause 10 yrs. ago	Malignant squamous-cell lining (pearl formation)
24759	W. F. 43	2 wks. ?	Benign	Left breast	Tumor, serous discharge, retracted nipple	Excision tumor, amputation breast (radical), 7-10-19	Living, not well, 5-16-30		Cyst, mature squamous-cell lining, keratin
24175							Lost		Cyst, mature squamous-cell lining
21490	W. F. 38	1 yr.		Right breast, areolar zone	Scab, blood, pus	Excision nipple, excision breast, 9-27-16	Well, 6-4-30		Cyst, mature squamous-cell lining
*21383	F. 61	10 yrs.		Left breast	Tumor (recurrent), retracted skin	Amputation breast (radical), 4-20-17	Lost		Malignant squamous-cell lining; malignant basal cell
21112	W. F. 50			Right breast	Wart, tumor	Excision cyst and wart, 3-8-17	Dead		Cyst, immature squamous-cell lining, keratin
16558	W. F. 68	6 yrs.	Dermoid	(Inner hemisphere)	Irritation, tumor, small (gradual growth), pain, tenderness	Excision tumor, 11-11-14	Lost		Cyst, squamous-cell lining, infiltration of leukocytes and giant cells
16597	W. F. 46	2½ mos.		Left breast, left upper quadrant; right breast	Pain, tumor, tenderness	Excision breast, left, 8-4-14 Amputation breast, right (Multiple cysts), 8-13-14	Well, 1915 (Lost), 1934		Cyst, immature squamous-cell lining and keratin, calcification
16552	W. F. 44	22 yrs.		Right breast, right upper quadrant	Tumor (gradual growth)	Excision tumor, 7-16-14	Lost		Cyst, squamous-cell lining
8612							Lost		Cyst, mature squamous-cell lining
*8708	C. F. 32	2 yrs.	Malignant	Left breast, left upper quadrant	Swelling, pain, tumor (adherent)	Amputation breast (radical), 1-25-08	Died, 1911 (cause unknown)		Malignant, squamous-cell lining
7332	W. F. 20	2 yrs.	Benign	Retention cyst	Tumor	Excision tumor, 8-9-06	Lost		Cyst, squamous-cell lining
5366						Excision tumor, 3-0-04	Lost		Cyst, squamous-cell lining
*5252	W. F. 64	3 mos.	Malignant	Dermod	Tumor, pain	Amputation breast (radical), 1-16-04	Died 1925 (metastasis to lungs)		Malignant squamous-cell lining
3432	F.		Benign	Right breast	Tumor	Excision tumor, 12-15-00	Died 1923 (asthenia)		Cyst, squamous-cell lining
*36143	W. F. 53	15 mos.	Malignant	Right breast, right quadrant	Tumor; discharge (6 mos.)	Amputation breast, 9-24-24	Lost, 1939		Cyst, malignant; squamous cell lining. Leukocyte infiltration

* Indicates malignant growth.

BENIGN DERMOID CYSTS

Clinical Features.—The cyst is usually subcutaneous, of variable size, sometimes hard, regular, circumscribed, freely movable, and usually painless. It occurs in the right and left breasts with approximately the same frequency. In the present series, 60 per cent of these tumors developed in the left breast. The average duration is 3.9 years, while the average age incidence is 58 years. Single cysts, as compared with multiple cysts, are found in approximately three-fourths of the cases. Unless the cyst develops to a noticeable size or becomes infected, it is often overlooked. In the present series, dermoid cyst was secondary to other pathology and, therefore, an incidental finding in 55 per cent of the cases. Thirty-three per cent of this number occurred in conjunction with malignant growths, while 67 per cent were incidental to benign lesions. The incidence of infection was found in approximately one-fourth of the cases. A small percentage of the histories showed evidence of infection, but because they did not have the corresponding microscopic sections, they were not classed as infected dermoids and for this reason the author thinks that the incidence of infection is higher than 28 per cent. The presence of infection gives the appearance of an abscess, but the history of a tense, doughy or slightly fluctuant mass being present and symptomless for weeks, which suddenly became inflamed, painful, tender and fluctuating, would readily rule out an ordinary abscess.

Gross Pathology.—These tumors are circumscribed, usually round, smooth-surfaced, and of varying size. The color and consistency vary with their contents. However, as a rule, they are grayish and moderately firm. When infection occurs they produce a reddening of the overlying skin and are themselves represented by a necrotic, cystic mass, walled off by a dense wall of fibrous tissue. The appearance of such infected tumors at operation may so closely resemble malignancy that even though a diagnosis of infected dermoid cyst is made clinically, a radical amputation of the breast is performed.

Microscopic Pathology.—Histologically, the lining of a dermoid cyst maintains epithelium which is identical to that of the normal skin. The proliferation of the squamous epithelium with keratinization is often seen together with an occasional papillary projection of the squamous-cell element within its lumen. The epithelial pegs, which are typical of the skin, are frequently found as a part of the outer wall of the cystic cavity. Occasionally keratin cysts may be seen in the wall of the dermoid. The derma, which may or may not be present, is difficult to distinguish from the normal subcutaneous tissue.

The association of sebaceous glands with dermoid cysts is frequently noted, and the relation between the two is probably an intimate one. The approximation between the sebaceous glands and dermoid cysts is so complete that the glands are seen emptying into the cystic cavity and in some cases seem to arise from a metaplasia of the same type of cell which developed the epithelial lining of the dermoids. The opening of the sebaceous

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glands into the cyst explains the presence of grumous material which is often seen within its lumen. However, with the exception of the infrequent presence of calcium, keratin, the result of a normal physiologic process in squamous cells, is the most frequent material found in dermoid cysts.

Infection seems to be prevalent in dermoids. Whether the cause originates from trauma alone, or from a lowered resistance to the part produced by a pressure ischemia, or whether the close approximation of the skin and sebaceous glands offers an ideal portal for the entrance of bacteria, is debatable.

The presence of severe infection is usually characterized by an ulceration of the cyst wall following an infiltration of the acute and chronic cells of inflammation, namely, polymorphonuclear leukocytes, lymph, plasma, and epithelioid cells, eosinophiles and giant cells. The giant cells are present in approximately one-fourth of the dermoid cysts. Sometimes the infection is so severe and extensive that mere shreds of epithelium are left behind (Path. No. 40856 and Path. No. 40640). Round-cell infiltration permeated by a few giant cells may be seen in the pericystic stroma (Path. No. 35495). This pericystic infiltration with the presence of giant cells leads one to believe that the tissue in the region of the dermoid is prone to infection, principally because of lowered tissue resistance. The relative frequency of giant cells creates the possibility of a chemotactic action produced by the cells of the dermoid cysts.

MALIGNANT CHANGE

As in all epithelial tissue, the lining of dermoid cysts is subject to malignant change. Such a change may be so gradual that it is usually overlooked clinically and recognized only with difficulty under the microscope. Malignancy occurs in 19 per cent of the dermoids. The average duration of these tumors is 2.3 years. They occur practically always in the female breast and are usually on the left side; they are seen most frequently at 54 years of age. These dermoids are associated with benign breast pathology in 14 per cent of the cases. When malignancy becomes apparent, it is noted that the cyst wall has a tendency to grow rapidly with the formation of new cysts, or pearly bodies (Path. No. 26149 and Path. No. 35934). However, the growth is usually irregular, widespread (Path. No. 21383, Path. No. 8708, and Path. No. 5252), and has a tendency towards cyst formation in 42.9 per cent of the cases. As the degree of malignancy progresses, the tendency towards cyst formation decreases and in the Grade IV type, the pathologic picture is represented by a disorderly arrangement of embryonic epithelial islands which infiltrate through the surrounding tissue (Path. No. 8708 and Path. No. 5252).

It is possible for malignant change to be so completely hidden by the signs of a superimposed infection that the clinical diagnosis is difficult and, at times, impossible to make. Although no such case was found in this series, mild infections were seen in a small percentage of the cases.

Grossly, these tumors are firm, irregular, infiltrating, and have a tendency to metastasize early.

Microscopic Pathology.—Microscopically, the epithelial cells, as compared to the normal, become larger, more vesicular, hyperchromatic, and have a tendency towards pearl formation. The epithelial pegs dipping down into the derma, frequently breaking through the basement membrane, are more prominent and irregular. Adjacent epithelial islands and cysts, resembling exaggerated epithelial pearls, are sometimes seen. Keratin may be found, but as the degree of malignancy increases, the tendency towards keratin formation decreases. As the tumor becomes more malignant, the epithelial tissue grows more profusely, forming epithelial islands with only an occasional cystic arrangement. This growth progresses to the extent that its latter stages of development cannot be distinguished from any form of malignant infiltrating squamous-cell carcinoma (Path. No. 21383). The absence of giant cells in the malignant dermoids of the present series indicates the rarity with which they are encountered.

Infection may complicate malignancy and if extensive enough may obliterate the morphology of cancer cells. However, when malignancy is present and a proper section of the tissue examined, a correct diagnosis can be made in a great majority of cases.

Discussion.—The origin of the simple dermoid cyst is questionable. Congenital misplacement of epithelium is the explanation offered by Remack¹ and Heschl.² Reverdin³ stresses the importance of implantation of epidermal fragments by trauma. In a small percentage of cases such an origin seems likely, although no case in the present study gave such a history. The origin may be explained by misplaced germinal centers which result either as a congenital or a postnatal anomaly stimulated by some intrinsic, or possibly extrinsic, source which governs the normal skin. Since isolated groups of epithelial cells have a tendency to keratinize, a concentric arrangement and desquamation of keratin explains the cyst formation.

Retention cysts are frequently confused with dermoids and in some cases they are indistinguishable. However, the retention cysts are usually recognized by their lining cells which are composed of compressed epithelial cells rather than the typical epithelial cells lining dermoids. The possibility of the migration of a retention cyst of the skin to the subcutaneous tissues has been shown by Chiari.⁴ The invagination of skin epithelium into a bottle-shaped structure with the narrow lumen of the epithelial growth sealed with keratin may so mimic a dermoid cyst that it is sometimes mistaken for one. Such a case was found among the sections of the laboratory. Caution should also be used in diagnosing cross-sections of inverted nipples for in many respects they closely resemble dermoid cysts.

The presence of a round, circumscribed, smooth, tense and sometimes fluctuant, movable, subcutaneous lesion of the breast should always arouse the suspicion of a dermoid cyst. A history of these findings occurring for a long period with a sudden development of abscess symptoms should im-

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mediately bring to mind the possibility of an infected dermoid (Path. No. 40640, Path. No. 16558, *etc.*). However, even though infected dermoid cysts are diagnosed clinically, they may resemble carcinoma so closely at operation that the surgeon performs an unnecessary mutilating radical amputation of the breast. Even though dermoid cysts are rare (36 cases in approximately 3,000 breast tumors), they should always be borne in mind, and above all, they should be remembered as being potentially malignant, for this change is seen in 19 per cent of the cases. The aid of transillumination, popularized by Cutler,⁵ should, as in all breast lesions, be employed, for it is the most reliable method of clinically distinguishing a cystic from a solid mass.

The treatment of dermoid cysts is best carried out by a local excision of the cyst followed by immediate microscopic study of the tissue removed. It is felt that if a dermoid cyst, proved by biopsy to be benign, is not totally removed, the possibility of recurrence, sinus formation and malignant change is too great to advise a less radical procedure. Two cases, Path. No. 30605 and Path. No. 28945, presented draining sinuses from improper treatment.

If the frozen section of the cyst proves malignant, a radical amputation of the breast should be performed.

Irradiation is valueless in malignant dermoid cysts for the cells are of the squamous (radio-resistant) variety.

CONCLUSIONS

(1) Dermoid cysts of the breast are believed to arise from misplaced basal epithelial cells (germinal centers) which are stimulated to activity by intrinsic and possibly extrinsic sources.

(2) The close association of sebaceous glands to dermoid cysts is emphasized. They are believed to arise from the same type of epithelium producing the dermoid cysts.

(3) Dermoid cysts of the breast are rare. Thirty-six cases were found in approximately 3,000 breast tumors.

(4) Eighty-one per cent of the dermoid cysts are benign, while 19 per cent are malignant.

(5) Dermoid cysts occur practically always in females. They also usually occur as a single lesion and are most frequently located in the left breast.

(6) The average age incidence and duration of symptoms of benign dermoids are 47.7 years and 3.9 years, respectively; in malignant growths they are 54 years and 2.3 years respectively.

(7) Benign dermoids are associated with other breast pathology in 55 per cent of the cases, while the malignant dermoids are similarly associated in only 28 per cent of the cases.

(8) Benign dermoid cysts are best treated by total excision of the tumor mass, while malignant dermoids are best treated by radical amputation of the corresponding breast.

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TUBERCULOSIS OF THE BREAST

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DURING the past decade a great plea has been made for the coöperation and combined treatment of certain medical problems, by both internist and surgeon. There is no question that such teamwork has been of material benefit to patients suffering from diabetes, thyroid and cardiac affections, peptic ulcers, and in more recent times, pulmonary tuberculosis. Such an opportunity presents itself in the management of tuberculosis of the breast.

History.—Tuberculosis of the breast was first recognized as a clinical entity in 1829, when Sir Astley Cooper¹ described the macroscopic features of a "scrofulous swelling of the busom." Dubar,² in 1881, was the first to establish the diagnosis upon a microscopic and bacteriologic basis. Ohnacker,³ in 1883, was the first to report the successful transmission of the disease to animals.

Morgen,⁴ in 1931, reviewed the literature and recorded 439 cases, of which 238 were primary and 157 secondary. He reported six additional cases. Since the publication of this paper 34 other cases⁵ have been reported.

When compared with the frequency of tuberculosis occurring in other organs of the body, tuberculous mastitis is relatively uncommon. From 1923 to 1933, 623 cases of diseases of the breast were admitted to the Jewish Hospital of Brooklyn. Of these 392 were tumors, of which ten were tuberculosis of the breast (1.4 per cent of all breast cases). In addition the hospital records show two cases in 1921.

Tuberculous mastitis may be classified clinically as primary and secondary. In the primary type the disease is confined to one breast, with or without involvement of the axillary nodes of the same side and there is no clinical evidence of active tuberculosis elsewhere. In the secondary type, there are manifestations of active tuberculosis in other organs, especially the lungs, pleura and ribs.

Considerable controversy exists regarding the manner in which the disease is contracted. Several explanations have been advanced.

(1) *Direct inoculation of the breast* through the abraded surface of the nipple or skin by way of the skin lymphatics; it is rarely conveyed through the milk ducts. Deaver⁶ limited the primary cases to this group.

(2) *Secondary inoculation of the breast* takes place by contiguity, through the blood stream or through the lymphatics.

Tuberculosis involving the breast by contiguity has been reported in several cases, the primary lesion being in the pleura, sternum or ribs. Most writers believed that the most probable route of extension was through the

blood stream. However, Nagaskima⁷ in 1925 definitely disproved this contention. He reported the autopsy findings of 34 cases of miliary tuberculosis, where careful sections of each breast had been taken. The breast was found to be the only organ free from evidence of tuberculosis. He concluded, therefore, that hematogenous infection of the breast occurs rarely, if ever. Morgen agrees with Deaver's conclusion that retrograde extension through the lymphatics is the most probable mode of infection. Morgen emphasizes the fact that the majority of people become infected with tuberculosis. The bacilli, however, may remain dormant in the tissues for some time. With lowering of local resistance in some particular part of the body, the tubercle bacilli are again liberated, and reach the breast through the lymphatic channels, probably by retrograde embolic processes (Deaver). The most important primary foci are the hilum, axillary, cervical and retrosternal lymph nodes.

Etiology.—Of the few cases where cultural identification of the tubercle bacillus was determined, the bovine type alone was found (Barker⁸). However, the number of these cases is too small to warrant conclusions. The cases are not limited to females; Morgen collected 20 cases occurring in males; four more have since been reported.^{5b, n, r, t} A history of trauma was elicited in seven per cent of Morgen's cases and in two of the cases to be presented. A variance exists in the statistical reviews regarding age predilection. In Morgen's series, the greatest age incidence was between 20 and 40; in Deaver's, between 30 and 50; in Kaufmann's,⁹ between 40 and 68. In our series, two cases occurred at 26, the others ranged from 33 to 53. Most of the cases occurred in married women who had borne children.

Pathology.—Tuberculosis of the breast is usually unilateral. The macroscopic appearance varies. Isolated or scattered foci of grayish-yellow granulation tissue appear, with associated caseation or suppuration and fibrous induration. The pathologic changes may be divided into three groups:

(1) *The Nodular Type* (discrete, disseminated and confluent).—The discrete nodular type occurs most frequently. The tubercle is usually situated in the connective tissue, rarely in the duct or periductal tissue. The acini are destroyed by the reactionary lymphatic infiltration. The tubercle enlarges, usually slowly, to form a mass varying in size from a small marble to a hen's egg; it rarely becomes larger. Caseation takes place, and if suppurative softening occurs, sinuses are formed. Daughter tubercles form at the periphery of the area in the disseminated type. In the confluent type liquefaction necrosis takes place in several of the tubercles and these caseous suppurative masses communicate with each other in various directions through fistulous tracts.

(2) *The Sclerosing Type.*—This type occurs in older people. It is characterized by chronicity; this allows of ample time for protective fibrosis to occur. As in fibroid phthisis there is a diffuse epithelioid and embryonic connective-tissue infiltration. The breast in its terminal stage is small, hard and shrunken.

(3) *Atypical Forms*.—The rarer forms are included in this group. (a) *Obliterating tuberculous mastitis* (obliteration of the ducts) has been described by Ingier.¹⁰ (b) *Intraglandular cold abscess* represents an advanced stage of the confluent nodular type, where deep-seated suppurating masses are present.

Tuberculosis may be present in association with other conditions of the breast; notably adenoma, fibro-adenoma and carcinoma. Lee and Floyd¹¹ collected ten cases with co-existing adenoma and seven with carcinoma. Recent literature cites three more cases occurring with carcinoma.^{5c, f, 1}

Diagnosis.—In eight of the 12 cases to be described the appearance of a nodule in the breast was the initial complaint. Pain occurred early in four of the cases; it was invariably present during the stage of suppuration. A thin purulent discharge from the nipple appeared in two of the cases. The duration in our series ranged from two weeks to seven months. Vandel¹² in his group of cases found the average duration for the primary cases 10.1 months; and from 11.2 to 12 months for the secondary cases.

Physical examination in most cases revealed no gross impairment of health. In only one of the 12 cases—the only secondary case—was there evidence of a marked loss of weight. The findings in the primary group were limited to the breast. The right one was somewhat more frequently involved than the left (seven of the 12 in our series and 204 of the 379 cases in Morgen's series). The lower quadrants were more frequently affected in our series. Early, a discrete, slightly tender nodule was noted. This either remained the same in size or became gradually larger, with the development of contiguous nodules. During the stage of liquefaction necrosis, tenderness increased and fluctuation was elicited, at which time the skin became adherent and showed signs of inflammation. With ultimate rupture of the skin, a sinus formed, and thin pus was discharged. Where the nodule was close to the areola, retraction of the nipple took place. The axillary lymph nodes were frequently enlarged (25 per cent of our series; and in Deaver's, 9 per cent of the primary, and 75 per cent of the secondary cases).

Differential Diagnosis.—Tuberculous mastitis must be differentiated from:

(1) *Tumors*: fibroma, fibro-adenoma, sarcoma, and carcinoma. Carcinoma was the most frequent preoperative diagnosis in most of the cases that were operated upon (three of the 12 cases in our series). The differentiation is important, because less radical measures than are usually necessary in carcinoma effect a cure in tuberculous mastitis. A diagnosis based on frozen section examination of all doubtful cases should be made at the time of operation. Sarcomata are rare, and are characterized by their rapid growth.

(2) *Pyogenic Mastitis*.—As a rule acute suppurative mastitis offers no problem in differential diagnosis. In subacute and chronic cases, histologic and bacteriologic examination is the only means of recognition.

(3) *Other Infectious Granulomata*.—Gummata of the mammary gland (mastitis gummata) are very rare. They are characterized by their chronic-

ity and extensive ulceration; when healing begins, deep retracting scarification results. Actinomycosis is extremely rare; it may be secondary to actinomycosis of the pleura and the lungs; Kaufmann⁹ reported one case and referred to four others. The ray fungus is to be sought for in the discharge.

The prognosis is unusually good in tuberculous mastitis with proper treatment. The occasional postoperative recurrence was limited to the secondary group.

Treatment.—(1) *Surgical.*—All the cases reported thus far in the literature were operated upon, since the accepted treatment is surgery. Where the condition is localized (discrete nodular variety), simple excision is all that is necessary. Where the involvement has become more widespread, a simple mastectomy should be performed. Radical mastectomy is never necessary. The accompanying lymph-node enlargement may receive roentgen therapy, heliotherapy, or surgical removal.

(2) *Nonsurgical Treatment.*—Von Eberts¹³ in 1909 suggested that early in the course of tuberculosis of the breast, where the disease is discrete and the patient is in good health, one is justified in postponing operative intervention until the effect of a course of tuberculin treatment has been tried, in conjunction with good hygienic care.

Case XII presented an opportunity to determine the efficacy of medical treatment. A biopsy of one of the nodules disclosed the tuberculous nature of the lesion, and guinea-pig inoculation confirmed this diagnosis. From December 7, 1933, and for the subsequent four weeks the patient received tuberculin (O.T.) by inunction. In addition she received ultraviolet irradiation up to the erythema dose. Treatments were given at four-day intervals. The first effect noted was cessation of the discharge from the sinuses. There was a progressive decrease in the size of the nodules. By the end of the fourth week, the nodules could no longer be felt, the patient's general health had improved and she had gained nine pounds. Although she had been urged to continue treatment for several months, the patient felt quite well and discontinued further treatment. She remained in good health for the next seven weeks. She then received a slight blow on her right breast. Within a week pain and swelling of the lower half of the right breast appeared and a mass the size of an orange was felt. The pain and tenderness were exquisite. Although a return to medical treatment was advised, because of the severity of the pain the patient insisted upon removal of the breast.

CASE REPORTS

CASE I.—No. 66064. Mrs. B. F., married, aged 37, mother of two children. Admitted to the hospital April 2, 1921. Eight weeks before admission, she left the hospital after the breast was incised for an abscess. At that time a small amount of pus was obtained. A thin purulent discharge has continued ever since. A few weeks later, two lumps appeared contiguous with the abscess. Pain was not present. Physical examination revealed the patient in good health and the heart and lungs normal. The left

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breast, lower inner quadrant, presented a linear incision from which a thin pus exuded. An ulcer, the size of a dime, was present at the outer edge of the areola. Two hard, nodular masses, each the size of a hen's egg, were found contiguous to the incision. These nodules were tender. No axillary nodes were felt. *Operation*: simple mastectomy. *Pathologic report*: tuberculous mastitis.

CASE II.—No. 68551. Mrs. M. S., married, aged 44. Admitted to the hospital September 21, 1921. Two and one-half months previously she was kicked in the right breast. A few days later she noticed a slight swelling in that breast, and this has continued to increase. Pain was not present. Examination revealed a woman in good health, heart and lungs normal. A firm, hard, nontender mass, the size of an orange, was found in the lower outer quadrant of the right breast. Roentgen ray of the lungs disclosed no abnormality. *Operation*: simple mastectomy. *Bacteriologic findings*: negative. *Pathologic report*: tuberculous mastitis.

CASE III.—No. 69808. Mrs. F. M., married, aged 47. Entered the hospital December 13, 1921. Six months before admission she noted a small nodule in the right breast. The condition remained unchanged until one week previously, when it began to enlarge and become painful. Examination revealed a woman in good health, heart and lungs normal. A mass, the size of a plum, tender and fluctuant, was found in the lower inner quadrant of the right breast. The skin over the mass showed signs of inflammation, but was not adherent. The lower outer quadrant presented a small nodular mass which was not tender. *Preoperative diagnosis*: carcinoma of the breast. *Operation*: radical mastectomy. *Pathologic report*: chronic inflammatory lesion characterized by connective-tissue replacement. The mass is infiltrated by plasma and round cells. Considerable epithelioid proliferation is present. An occasional giant cell is seen. There are many areas of caseation necrosis. *Impression*: tuberculous mastitis.

CASE IV.—No. 77036. Mrs. S. G., married, aged 26, mother of two children. Entered the hospital February 23, 1923. Three months ago she noticed a lump in the left breast; it has since become larger and painful. Examination revealed a well-developed woman, apparently in good health. Several small nodules, each the size of a marble, were found in the lower outer quadrant of the left breast. The skin over some of the nodules showed signs of inflammation; tenderness was marked. *Operation*: simple mastectomy. *Bacteriologic report*: many acidfast bacilli present. *Pathologic report*: many tubercles are seen; they are characterized by the presence of collections of epithelioid cells and many giant cells. Many areas of caseation necrosis are seen. There is an increase in fibrous tissue. *Impression*: tuberculous mastitis.

CASE V.—No. 77039. Mrs. S. S., married, aged 33. Entered the hospital April 8, 1923. In January, 1923, the right breast was incised and drained. The discharge persisted; and six weeks later a section was removed for pathologic study. For a few weeks before admission to the hospital, she noticed nodules in the right breast; they have become larger and more painful. Examination revealed a woman apparently in good health, heart and lungs normal. Three incisional wounds discharging a thin pus were found in the lower inner quadrant of the right breast. A small mass, the size of a walnut, was palpated. It was hard and tender and not adherent to the skin. *Operation*: simple mastectomy. *Pathologic report*: evidence of chronic inflammation, with considerable fibrosis and marked destruction of the parenchyma is noted. Also, there are to be seen, areas of tubercle formation with perivascular round-cell infiltration, giant cells and areas of necrosis. *Impression*: tuberculous mastitis.

CASE VI.—No. 78696. Mrs. E. S., married, aged 42. Entered the hospital May 22, 1923. Two weeks before admission she noticed a hard mass in the right breast. She felt a drawing sensation, but no pain. Examination revealed a woman apparently in good health, heart and lungs normal. A hard and tender mass, the size of a plum, and not attached to the skin, was found in the inner, lower quadrant of the right breast. *Preoperative diagnosis*: carcinoma of the breast. *Operation*: radical mastectomy. *Pathologic*

report: microscopic examination shows the presence of a diffuse chronic inflammation. Many epithelioid and round cells are found in the arrangement characteristic of tuberculous lesions. Fibrosis is also noted. *Impression:* tuberculous mastitis.

CASE VII.—No. 86627. This case illustrates the only true secondary type of involvement in our series. Mrs. E. S., married, aged 37, mother of three children. Entered the hospital August 12, 1924. Four weeks before admission she had pain in her left breast and noted the presence of a small mass. Examination revealed a mass, the size of a marble, in the lower outer quadrant of the left breast. A thin serous discharge issued from the nipple. Tenderness was not elicited, and the mass was not adherent to the skin. The general condition of the patient appeared good, but examination of the chest disclosed significant findings: bronchovesicular breathing and inspiratory crepitant râles over both apices. *Operation:* simple mastectomy. *Pathologic report:* the mass shows the presence of inflammatory reaction with many plasma cells and several giant cells. Considerable fibrosis and many epithelioid and round cells in typical tubercle formation are seen. *Diagnosis:* tuberculous mastitis.

CASE VIII.—No. 118075. Mrs. E. S., aged 44, married, mother of seven children. Entered the hospital January 29, 1929. Three weeks before admission she noticed a discharge from the left nipple. Two weeks later, the left breast became swollen, hot and painful. Examination revealed a woman apparently in good health, heart and lungs normal. Roentgen ray examination of the chest disclosed no abnormality. A large red area was found around the nipple of the left breast. The nipple was small and retracted and beneath it a large, circumscribed, tender mass, the size of a hen's egg, was felt. A few nodes were palpated in the axilla and in the supraclavicular region on the left side. *Operation:* excision of mass. *Pathologic report:* sections of the breast show numerous tubercles, with epithelioid and giant cells. Areas of necrosis and hyalinization are noted. *Impression:* tuberculous mastitis.

CASE IX.—No. 136099. Mrs. R. S., aged 36, married, mother of three children. Entered the hospital January 29, 1931. The patient stated that she had not been feeling well for some time, and had lost considerable weight. Nineteen months before admission, she noticed her left breast getting larger. Four months later she felt a mass in the breast. Examination revealed a patient who had apparently lost considerable weight; the heart and lungs showed nothing abnormal. A tender, irregular, nodular mass, the size of a hen's egg, was found in the lower outer quadrant of the left breast. The mass was not adherent to the skin, but the nipple was retracted. A few nodes were palpated in the left axilla. *Operation:* resection of mass, partial mastectomy. *Pathologic report:* several masses of breast tissue, containing cystic areas and lined by a gray necrotic membrane are seen. On section, these masses are made up of pearly-gray tissue containing a few nodules. No tubercle bacilli were found. Microscopic examination shows the presence of a diffuse chronic inflammation, characterized by a diffuse round cell infiltration and a collection of epithelioid cells arranged in the manner, characteristic of tuberculosis. An occasional giant cell is seen. *Impression:* tuberculous mastitis.

CASE X.—No. 147968. Mrs. R. K., aged 36, married, mother of three children. Entered the hospital March 28, 1932. The patient noticed a small painful nodule in her right breast. Examination revealed a patient in good health, heart and lungs normal. A small tender nodule, the size of a marble, was found in the upper, outer quadrant of the right breast. Axillary nodes were not found enlarged. *Operation:* partial mastectomy; wide excision of mass. *Pathologic report:* the mass is yellowish-gray in color and of soft consistency. On section it is found to be granulomatous in nature; it is infiltrated with round cells and a few polymorphonuclear leukocytes and plasma cells. A large number of epithelioid cells are present and many giant cells are seen. There is a considerable degree of fibrosis as well as central necrosis. The inflammatory process extends along the lymphatics and enters some of the neighboring acini. *Impression:* tuberculous mastitis.

TUBERCULOSIS OF THE BREAST

CASE XI.—No. 161571. Mrs. M. S., aged 53, mother of seven children. Entered the hospital July 5, 1933. Seven weeks before admission she noticed swelling of the right breast, and the appearance of a painful mass. Examination revealed a patient in good health, heart and lungs normal. An irregular, tender mass, the size of a lemon, was found in the upper, inner quadrant of the right breast. It was not adherent to the skin. A few nodes were palpated in the right axilla. *Preoperative diagnosis:* carcinoma of the right breast. *Operation:* radical mastectomy. *Pathologic findings:* section shows the mass to consist of multiple tiny cysts, clogged with an inspissated, clay-colored fluid. The structure is definitely granulomatous, consisting of many round, epithelioid and giant cells; some fibrosis is present. *Impression:* tuberculous mastitis.

CASE XII.—No. 165214. Mrs. F. M., aged 26, married, mother of two children. Admitted to the hospital on our service, November 21, 1933. Twelve weeks before

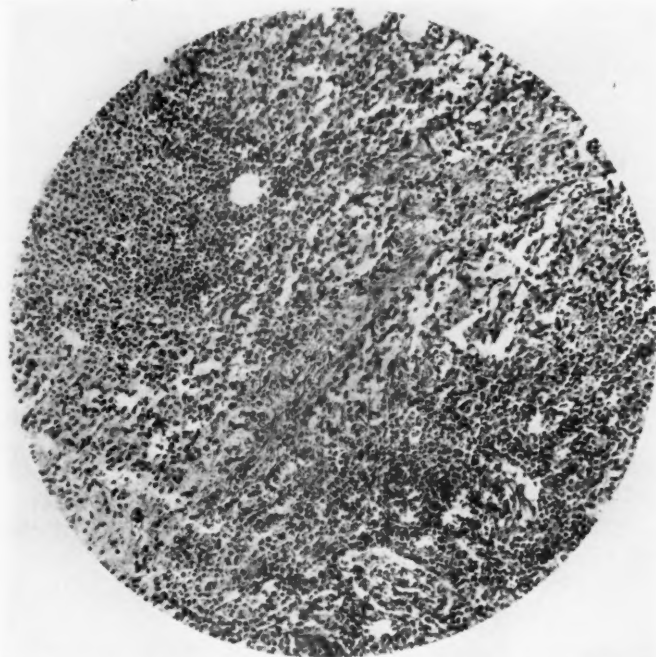


FIG. 1.—(CASE XII.) Section of breast showing numerous epithelioid tubercles.

admission she noticed a painful, tender swelling in the right breast. This became progressively worse, and the skin became inflamed. An incision was made two weeks later and some thin pus obtained. A second swelling appeared along the side of the incision and this too was incised, with the resultant discharge of a similar pus. The two nodules became larger, and a third one appeared on the outer side of the second incision. Examination revealed a patient in good health, and the heart and lungs normal. Roentgen ray examination of the chest showed no abnormality. Three swellings, varying in size from a marble to a walnut were found in the lower, outer quadrant of the right breast. The two larger ones, which had been incised, were still discharging thin pus. The nodules were tender and the skin over them was inflamed.

A diagnosis of tuberculosis of the breast was made. The smaller of the nodules was removed for study. *Pathologic report:* the small nodule is two cm. in diameter, and soft in consistency. The tissue is of a granulomatous nature, characterized by an

infiltration of many round and epithelioid cells; some giant cells are seen. A considerable amount of necrosis is present (Fig. 1). *Impression:* tuberculous mastitis. *Guinea-pig inoculation* was subsequently reported positive.

We advised conservative medical treatment in this case. The patient left the hospital December 1, 1933, at which time there was an oozing of thin pus from each of the incisions. The larger two nodules were still present and exquisitely tender.

Beginning December 7 patient reported at four-day intervals for medical treatment. At each visit she was given an ultraviolet irradiation up to the erythema dose. A Hanovia air cooled, mercury vapor, quartz lamp was used. Tuberculin ointment was rubbed into the skin for three minutes. Tuberculin (O. T.) is readily absorbed through the skin and may be conveniently applied in a fatty base (Rx. Tuberculin (O. T.), 0.40; adeps lanae hydrosus, 4.00; misce et fiat unguentum. Sig. Tuberculin Ointment, 10 per cent).

The skin of the outer aspect of the arm was cleaned with ether and alcohol. A quantity of ointment, the size of a split pea, was gently rubbed into the skin with a glass spatula for three minutes. In the course of 18 to 36 hours, an erythematous area appeared, which was rarely followed by papulation. Systemic effects did not appear. The application was repeated every fourth day. When the 10 per cent ointment failed to produce erythema, a 25 per cent ointment was used; finally a 50 per cent ointment was employed. At the end of two weeks the wounds became dry and the discharge had ceased. At the end of four weeks the nodules had practically disappeared and the patient had gained nine pounds. The necessity for continuing treatment for six months to one year was impressed upon the patient. She felt so well, however, that she thought further treatment was not essential. She continued in good health for the next eight weeks. She then received a blow on the right breast, which began to swell and appeared inflamed.

On May 7, 1934, a mass the size of an orange was palpable. It was exquisitely tender, and the skin over the mass was inflamed. The mass occupied the lower, outer quadrant of the breast. The axillary and cervical nodes were not enlarged. We advised her to resume medical treatment. However, because the pain was so severe, she insisted on immediate relief. She was admitted to the hospital and a simple mastectomy was performed. *Pathologic report:* the breast shows an advanced inflammatory process. Scattered throughout are numerous epithelioid tubercles, some containing giant cells. The presence of necrosis and a large number of polymorphonuclear leukocytes is indicative of a superimposed infection. *Impression:* tuberculous mastitis. *Bacteriologic study:* negative findings.

CONCLUSIONS

The response in Case XII to treatment by heliotherapy and tuberculin (O.T.) was gratifying. Whether the ultraviolet rays or the tuberculin (O.T.) played the predominating rôle in the result obtained, is conjectural. Unfortunately, because of the patient's refusal to continue further medical treatment, the case was terminated surgically. The result was sufficiently satisfactory, however, to warrant a trial of heliotherapy, or tuberculin (O.T.) therapy, or both, in similar cases.

Heretofore, all cases of tuberculous mastitis have been treated surgically. Coöperation of the surgeon and the internist will make possible the diagnosis sufficiently early, so that medical treatment can be instituted. Any form of medical treatment that offers the possibility of cure, without subjecting a young woman to the humiliation consequent to the loss of a breast, is deserving of a thorough trial.

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TABLE I
Analysis of Case Reports

Case	Sex	Age	Social Status	Children	Method of Contraction	Initial Symptoms	Trauma	Pain	Site	Quadrant Involved	Size	Duration	Nipple	Condition of Skin	Axillary Lymph Nodes	General Health	Bacteriology
1	F	37	M	2	Primary	Appearance of a lump in breast	No	No	Left	Lower inner	Hen's egg	8 wks.	Normal	Signs of inflam.	None	Good	—
2	F	44	M	—	Primary	Swelling of breast	Yes	No	Right	Lower outer	Small orange plum	10 wks.	Normal	No inflam.	None	Good	Not active
3	F	47	M	—	Primary	Appearance of nodule in breast	No	Late	Right	Lower inner and outer	Plum	6 mos.	Normal	Signs of inflam.	None	Good	—
4	F	26	M	2	Primary	Pain and swelling of breast	No	Early	Left	Lower outer	Marble	3 mos.	Normal	Signs of inflam.	None	Good	Numerous acid-fast bacilli
5	F	33	M	—	Primary	Pain and swelling of breast	No	Early	Right	Lower inner	Walnut	4 mos.	Normal	Signs of inflam.	None	Good	—
6	F	42	M	—	Primary	Appearance of mass in breast	No	No	Right	Lower inner	Plum	2 wks.	Normal	No inflam.	None	Good	—
7	F	37	M	3	Secondary	Appearance of nodules in breast	No	No	Left	Lower outer	Marble	4 wks.	Milky discharge	No inflam.	Present	Rales in chest	—
8	F	44	M	7	Primary	Discharge from nipple	No	Late	Left	Under nipple	Hen's egg	3 wks.	Retracted	Signs of inflam.	Present	Good	—
9	F	36	M	3	Doubtful	Swelling of breast	No	Late	Left	Lower outer	Hen's egg	10 mos.	Retracted	No inflam.	Present	Loss of weight	Negative
10	F	36	M	3	Primary	Pain and nodule in breast	No	Early	Right	Upper outer	Marble	—	Normal	No inflam.	None	Good	—
11	F	53	M	7	Primary	Nodule in breast	No	Late	Right	Upper inner	Marble	7 wks.	Normal	No inflam.	Present	Good	—
12	F	26	M	2	Primary	Pain and nodule in breast	Yes	Early	Right	Lower outer	Walnut	7 mos.	Normal	Inflam. present	None	Good	Positive

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ACUTE CHOLECYSTITIS ASSOCIATED WITH PANCREATIC REFLUX

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IN 1901, Opie¹⁴ reported a case of acute hemorrhagic pancreatitis in which autopsy disclosed a calculus, occluding the duodenal orifice of the ampulla of Vater, but so small that the orifices of the choledochus and pancreatic duct were unobstructed. The two ducts, therefore, were converted into a continuous channel. This made possible the retrojection of bile into the pancreatic duct which probably accounted for the acute pancreatitis present. Stimulated by Opie's observation, other instances of acute pancreatitis were reported in which the pancreatic tissues were bile stained.

Interest was then aroused as to the different anatomic arrangements of the ducts in relation to the ampulla of Vater, and in which type of variation the lodgment of a small stone would convert both ducts into one continuous channel. Investigators have reported varying results. Mann and Giordano¹² concluded that in 3.5 per cent of their dissections the termination of the ducts was such that a continuous channel could be effected if the papilla were obstructed. From roentgenologic studies of ducts injected with lipiodol, Schmieden and Sebening¹⁷ found that this anatomic arrangement was present in 20 per cent of their cases. Subsequently, by occluding the papilla with a small stone and pouring Woods metal into the choledochus, Cameron and Noble⁶ noted that the pancreatic duct was in the mold of 75 per cent of the preparations. If the biliary reflux is to be considered in the etiology of acute pancreatitis, there must be other factors causing papillary obstruction inasmuch as the incidence of a stone occluding the ampulla is small.

In a collected series of 1,278 cases of acute pancreatitis, Schmieden and Sebening found that the ampulla was obstructed by a calculus in only 4.4 per cent, and in a series of 51 cases of primary acute pancreatitis reported by one of us⁸ in 1930, a papillary calculus was found in only one instance, although the common duct was definitely dilated in seven. The statement was made then that "the ampulla of Vater may be occluded either reflexly, or by the edema and spasm incident to the passage of stone in some cases, and in others by an inflammatory pancreatic enlargement."

Undoubtedly, edema of the papilla and spasm of the sphincter of Oddi not infrequently convert the choledochus and duct of Wirsung into one channel. Balo and Ballon² reported the necropsy findings in four cases of simple catarrhal jaundice without stone in which a retention of pancreatic juice and simultaneous jaundice was presumably due to swelling and edema of the

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duodenum and papilla. The rôle of spasm of the sphincter of Oddi was stressed and verified by Archibald¹ in his work on this sphincter in cats. This was subsequently corroborated by Westphal¹⁸ who made a detailed study of the actions of the muscles near the orifices of the choledochus and the large pancreatic duct, and emphasized the functional importance of this muscular area in normal and pathologic processes. In addition, he demonstrated in 42 of 50 cadavers that the anatomic relationships were such that the flow within the bile and pancreatic ducts could occur in either direction.

However, there is even more conclusive clinical evidence proving that spasm or edema under certain anatomic conditions may convert the orifices of the choledochus and the duct of Wirsung into a cloaca, resulting in the appearance of pancreatic ferments in the bile. This is well recognized by the occasional occurrence of severe skin digestion about biliary fistulae. Chemical analysis of the biliary discharge in these cases invariably discloses the presence of pancreatic ferments in large amounts. These ferments can only be accounted for by pancreatic reflux in the absence of duodenal contents either from a fistula or retrojection. Nordmann¹³ recorded two cases of acute pancreatitis in which pancreatic ferments were present in the drainage from a choledochostomy, and Westphal,¹⁸ too, demonstrated large quantities of ferments in a dilated choledochus.

But pancreatic ferments are not as infrequent in the biliary system as these few isolated instances would seem to indicate. In a recent communication, Popper¹⁵ stated that he examined the bile (usually from the gallbladder) in 219 surgical cases for the purpose of finding pancreatic ferments. The samples examined represented cases of cholelithiasis, tumors of the pancreas, acute pancreatic disease, and cases with a healthy biliary system. Diastase was routinely sought for as a proof of the presence of pancreatic juice. Ferments were demonstrable in 17 per cent of the cases, and if those of acute pancreatic disease were excluded, 20 of 200 bile samples contained diastase. The cases in which the bile ducts contained pancreatic juice differed in no way from other cases of cholelithiasis in respect to case history, symptomatology, clinical course, operative condition, or postoperative course. Subsequent follow up examinations, months or years later, showed no indication whatsoever of any pancreatic or hepatic dysfunction. Evidently the reflux of pancreatic ferments into the bile passages is of pathologic significance only when there is prolonged blockage of the ampulla in association with other conditions.

Once a common channel has been established, the direction of flow is undoubtedly dependent upon the relative secretory pressures of the bile and pancreatic juice. Investigators are not in accord, however, as to these pressures, but the weight of evidence seems to favor the pressure as being higher in the pancreatic duct.¹¹ Hence the increased likelihood of ferments being found in the bile, rather than bile in the pancreatic duct. However, intra-ductal pancreatic pressure may be lower if the accessory duct of Santorini is present. When this communicates with the duct of Wirsung, it might

easily act as a safety valve and diminish the pressure in the main duct sufficiently to permit bile to flow into the pancreas. When this occurs, an acute pancreatitis may follow. If, however, the flow is in the opposite direction, and pancreatic juice enters the choledochus, an acute cholecystitis, or more rarely a nonperforative bile peritonitis may ensue.

Cases of nonperforative bile peritonitis bear an interesting relationship to pancreatic reflux. In 1910, Clairmont and Haberer⁷ reported a case of bile peritonitis without perforation of the bile passages. They suggested that this might have been caused by alteration of the permeability of the bile duct walls, but offered no explanation for its occurrence.

Blad³ later endeavored to explain these unusual cases from a correlation of chemical and animal experiments. He felt that the pancreatic ferments refluxly present in the biliary system in association with bacterial action digested the colloids of the bile and liberated the pigment which by some unknown process could pass through any membrane.

By injection of human pancreatic juice into the choledochus of animals, Westphal¹⁸ was able to produce acute and chronic pathologic changes in the liver, gallbladder and extrahepatic bile ducts, many of which were comparable to those found in the human. He felt that the action of trypsin must be considered an uncommon, but nevertheless an important factor in the production of cholecystitis, in addition to infection, lithiasis, stenosis, or motor dysfunction of the biliary passages.

Wolfer¹⁹ subsequently verified Blad's observations and some of Westphal's by a series of ingenious experiments based upon the entrance of pancreatic juice into the gallbladder. He concluded that these ferments so devitalized the gallbladder wall that bacterial invasion, especially of anaerobes, was favored. He also felt that the alkalinity of the pancreatic juice transferred the ordinarily acid medium of the gallbladder bile into an alkaline one, and that this might account for the violent reaction in the mucosa of the gallbladder.

The exact mechanism of the chemical inflammatory reaction occurring in cases of acute cholecystitis in which pancreatic ferments have been found in the gallbladder bile is doubtful. It is evident from a review of the literature, especially the work of Popper,¹⁵ that pancreatic ferments may be present within the biliary tract and cause no damage. However, under certain conditions, the mixture of bile and pancreatic juice otherwise apparently innocuous, may be converted into a destructive tissue irritant, resulting in an alteration of the permeability, and in a chemical inflammation of the gallbladder wall. Dragstedt, Haymond, and Ellis⁹ have recently thoroughly reviewed the pathogenesis of acute pancreatitis. They called attention to many facts which might explain the production of acute cholecystitis by the presence of pancreatic ferments in the bile. Nonactivated pancreatic juice as it exists in the duct system of the pancreas is nontoxic, either on intravenous or intraperitoneal injection, and even activated trypsin is not able to destroy healthy living tissue. Bile apparently produces its local toxic and cytolytic effects

through the bile salts, which have been shown to constitute the toxic element in bile. Gallbladder bile, because of its greater concentration of bile salts, should be and undoubtedly is more effective in its destructive activity than hepatic duct bile. There is, however, an important element which tends to neutralize the destructive effect of an increased concentration of bile salts in the gallbladder. Bile as it is secreted by the liver is invariably alkaline, whereas under normal conditions the bile in the gallbladder tends to be kept acid through the selective concentrating activity of that organ. Bile salts are far more soluble, and, therefore, much more toxic under alkaline than under acid conditions. If a large quantity of pancreatic juice is retrojected into the gallbladder, the alkalinization of the normally acid gallbladder bile, together with the presence of pancreatic ferments probably activated by infected bile, produce conditions favorable for tissue destruction. Trypsin, now activated, may act in several ways. It may digest the proteins which have a definite protective action against the destructive effects of the bile salts. It may remove the taurine and glycine from the conjugated bile salts, liberating the more toxic free bile acids. Finally, it may be regarded as an active catalyst and, as such, accelerate a reaction which otherwise would take place slowly, thereby increasing and enhancing the toxic effect of the bile.

Active pancreatic ferments have been found in the bile of acutely inflamed gallbladders, and their presence appears definitely related to the acute inflammatory process present. Such instances have been reported by Bundschuh,⁵ Ruppner,¹⁶ Dziembowski,¹⁰ and Brackertz.⁴ Three similar cases of acute cholecystitis associated with the presence of pancreatic enzymes in the gallbladder bile have been observed on the Surgical Services of the Mount Sinai Hospital during the past year.

CASE REPORTS

CASE I.—History No. 357862, M. McG., a well-developed and stout Irish laborer of 65, was admitted to the Surgical Service of Dr. Harold Neuhoof on October 7, 1933, for acute urinary retention due to prostatism. On October 13, 1933, a suprapubic cystostomy was performed. Two days later, without ever having had any previous symptoms of a similar nature, while lying in bed, he developed sudden acute persistent pain in the right upper quadrant. On examination, the gallbladder was found to be palpable, markedly tender and distended. Temperature 103°. The symptoms disappeared within two days. Ten weeks later, while convalescing from a second-stage prostatectomy, the same symptoms suddenly recurred and after three days of conservative treatment, it was felt that operation was indicated. On opening the peritoneal cavity, the gallbladder was found to be distended. The wall was thickened, edematous and gangrenous in several areas, and covered with recent omental adhesions. It contained 60 cc. of thick dark bile and several small cholesterol stones in the cystic duct. Free, bile-stained fluid was found in the peritoneal cavity, although no visible perforation was apparent in the gallbladder wall. After its removal, the gallbladder was distended with formalin and no perforation was found. The liver was normal in appearance. Convalescence was uneventful. On analysis the gallbladder bile was found to be markedly alkaline with a pH of 7.75 (normal 6.8 to 7.1). By qualitative tests, large amounts of both amylase and trypsin were found to be present. Cultures of both the bile and gallbladder wall were found to be sterile.

Microscopic Findings.—Sections were taken from the fundus, neck and ampulla of

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the gallbladder. These showed essentially identical changes. The mucosa and lamina propria were necrotic. There was a marked polymorphonuclear leukocytic infiltration immediately below the epithelium which extended down through the muscular and fibrous coats and subserous tissues to the serosal wall (Fig. 1). The entire wall was edematous and a pronounced fibrinous exudation was present. The vessels were dilated and engorged, and frequently surrounded by polymorphonuclear leukocytes, which, at times, extended into the wall of the vessels. The lymphatics were likewise dilated and filled with nuclear debris. No fat necrosis was observed microscopically. The entire gallbladder was then stained with Benda's solution and carefully sectioned for evidences of fat necrosis. None were found. Bacteria were not found in the microscopic sections.

CASE II.—History No. 363431, R. M., a well-developed, rather thin 25-year-old Porto Rican woman, was admitted to the Surgical Service of Dr. Harold Neuhof on March 7,



FIG. 1.—(CASE I.) Photomicrograph of gallbladder wall showing acute diffuse inflammation. Diffuse polymorphonuclear leukocytic infiltration of wall with marked edema (hematoxylin and eosin).

1934. For the past 18 months she had suffered from six acute attacks of sharp pain in the right upper quadrant, radiating to the epigastrium and occasionally to the back. The pain was accompanied by nausea, vomiting and slight jaundice. Each attack persisted about two weeks during which time there would be only intermittent amelioration of the symptoms. In the intervals between attacks, belching and distention were marked; fatty foods could not be tolerated. The last attack, which began two days before admission, was the most severe and persisted up to the time of operation. On admission, unusually acute tenderness was noted in the right upper quadrant. Temperature 101°. At operation, five days after the onset of the last attack, the liver was found enlarged, extending about five cm. below the costal margin. It was deep red and congested. The gallbladder was closely surrounded by edematous omentum containing several areas of fat necrosis. Upon careful separation of the omentum from the gallbladder, a thin layer of definitely bile-tinged fluid was found. The gallbladder itself was enormously distended. The edematous thickened walls showed many areas of gangrene and fat necrosis. One hundred cm. of blackish bile were aspirated and several buckshot-sized cholesterol

stones were found in the cystic duct. Because of the acute inflammatory process, cholecystectomy was performed without further exploration. The patient was discharged on the 13th day, after a smooth convalescence.

The gallbladder bile was found to be alkaline with a pH of 7.78 and contained 450 Elman units of amylase per cc. Trypsin could not be detected. Cultures of both the gallbladder wall and the bile were found to be sterile.

Microscopic Findings.—Numerous sections from various areas of the gallbladder revealed identical changes. There was a marked necrosis of the mucosa extending into the subepithelial tissues, and in many places into the muscularis and subserous tissues. A diffuse polymorphonuclear leukocytic infiltration was present throughout. These cells were often collected in masses about necrotic foci. The vessels were dilated, the walls often infiltrated by leukocytes, and the lymphatics were filled with pyknotic debris.



FIG. 2.—(CASE II.) Photomicrograph of gallbladder wall showing large subserous area of fat necrosis. Calcium deposit surrounds necrotic fat cells. Entire area surrounded by a wide zone of inflammation (hematoxylin and eosin).

The entire subserosa, in many sections, contained extensive areas of fat necrosis (Fig. 2), the necrotic fat cells taking a deep blue color with the hematoxylin and eosin stain. The necroses frequently involved the serosa, although microscopically it was not possible to determine whether actual perforation had occurred. The entire gallbladder was stained with Benda's solution. This revealed many scattered subserosal areas of fat necrosis (staining a deep green color) chiefly present on the free surface of the gallbladder. Bacteria were not found in the microscopic sections.

CASE III.—History No. 371810, A. L., a well-nourished Italian woman of 41, was admitted to the Surgical Service of Dr. Ralph Colp on October 6, 1934. The patient had been perfectly well up to 15 hours before admission when she suddenly developed epigastric pain which spread to the periumbilical region and to the right lower quadrant. After two hours, the pain suddenly became very severe and was accompanied by chilly sensations and vomiting. On admission, the patient appeared to be acutely ill and in

great pain. Tenderness and rigidity were marked on the right side of the abdomen; the right upper quadrant being excruciatingly tender. Temperature 101.4°.

Nineteen hours after the onset of symptoms operation was performed. Grayish pus was found free in the upper abdomen and over the superior surface of the liver. The gallbladder was greatly distended, acutely inflamed, and the wall thickened and edematous. One small point of gangrene was noted but the gallbladder was found subsequently not to be perforated. Cholecystectomy was performed. Fever persisted for two weeks rising to 102° at times. On the ninth day postoperatively, bile began to flow through the site of drainage. This persisted until the 20th day when five very small mulberry-shaped cholesterol stones were discharged through the sinus, following which the sinus closed rapidly. The patient was discharged on the 35th day, symptom free.

The gallbladder bile was found to be very alkaline, the pH being 8.85. Both



FIG. 3.—(CASE III.) Photomicrograph of gallbladder wall showing focal necrosis of mucosa and diffuse submucosal infiltration of polymorphonuclear leukocytes with marked edema. A dilated lymphatic vessel is filled by leukocytic exudate (hematoxylin and eosin).

trypsin and amylase were present in large quantities; the amylase being 200 Elman units per cc. The blood amylase taken at the time of operation was 2.6 units. Culture of the gallbladder wall and gallbladder bile showed the presence of both *Bacillus Friedländer* and *Bacillus coli*. Culture of the peritoneal pus was sterile.

Microscopic Findings.—There was a widespread necrosis of the mucosa of the gallbladder. The necrotic areas were surrounded by dense infiltrations of polymorphonuclear leukocytes. The entire wall showed a most striking edema, together with a diffuse polymorphonuclear leukocytic infiltration, which extended to the serosal wall (Fig. 3). The latter was covered in areas by fibrinous exudate. In addition to the edema, there was an exudation of fibrin which was present in the form of wide bands, chiefly in the subserous and fibromuscular layers. The lymphatic and blood vessels were dilated and engorged. The entire gallbladder was stained with Benda's solution but no areas of fat necrosis were found upon careful sectioning. No bacteria were found in the microscopic sections.

The history and physical findings in these three cases are typical of acute gallbladder disease. While the inflamed gallbladders, presented the characteristic pathologic changes noted in the various stages of acute cholecystitis without perforation, there were other features present which were unique or unusual and not found in a control series of 70 cases of acute and chronic gallbladder disease.

In Cases I and II, free bile was present in the peritoneal cavity, and in Case II, fat necrosis was seen not only throughout the gallbladder wall, but also in the omentum adherent to the inflamed gallbladder. The cultures were sterile in the first two cases, and *Bacillus coli* and *Bacillus Friedländer* were present in the third. No bacteria were found in the microscopic sections of the gallbladder in any of the three cases.

The gallbladder bile was definitely alkaline in all cases. Diastase was present in large amounts in the bile aspirated from the gallbladder at the time of operation. The amounts of pancreatic ferments present could only be accounted for by pancreatic reflux. Retrojection of duodenal juice charged with pancreatic ferments into the bile ducts can be excluded together with the assumption that pancreatic ferments entered the bile by way of excretion by the gallbladder mucosa, or through the blood or lymph streams.

Pancreatic reflux as an initiating or precipitating cause of acute cholecystitis is probably more common than the paucity of cases reported would seem to indicate. If pancreatic ferments are found as frequently as Popper reports, their rôle, under certain conditions, not only in acute cholecystitis but also as a possible causative agent in the production of chronic gallbladder disease as Westphal has shown experimentally, cannot be denied.

Methods.—In the first case presented, the determination of both amylase and trypsin was done by qualitative methods, made roughly quantitative by using varying dilutions. Thus the amylase determination was estimated by the disappearance of the blue color produced by iodine in a 1 per cent starch solution incubated with varying dilutions of the bile. It was noted that a fourfold dilution produced splitting of the starch. Similarly a Mett tube showed digestion of the albumen in this sample diluted six times, evidence of a fairly high concentration of trypsin.

In Cases II and III, the amylase was determined quantitatively by means of the viscosimeter method of Elman, in which the equivalent of one unit of amylase, acting for one hour on five cc. of a 3 per cent starch solution, reduced the viscosity by 20 per cent. The starch solution was standardized so that various samples of normal human serum gave an amylase content of two to five units.

Amylase determinations of bile obtained from other cases of both acute and chronic cholecystitis were attempted. In such cases only unmeasurable traces of amylase could be detected. The presence of trypsin was assayed by incubating the bile with Mett tubes. The pH was determined in all cases potentiometrically by means of the hydrogen electrode.

CONCLUSIONS

It has been shown that if certain anatomic relationships exist between the choledochus, duct of Wirsung and the papilla of Vater, both ducts may be converted into a single continuous channel by obstruction of the papilla. This papillary obstruction might be caused either by a calculus, or by edema of the duodenum and papilla, or by spasm of the sphincter of Oddi muscle.

Once a single channel has been established, bile may flow into the duct of Wirsung or pancreatic juice may flow into the choledochus. The varying intraductal pressure is probably the factor which determines the direction of the flow.

If pancreatic juice refluxly enters in the biliary system, no clinically recognized sequelae may result. On the other hand, if the pancreatic ferments are present in the gallbladder bile in sufficient concentration and amounts to change its usual acid reaction to alkaline, the bile salts may act destructively on the gallbladder wall together with the activated pancreatic ferments. As a result of the chemical inflammation caused by these various factors, either an acute cholecystitis or nonperforative biliary peritonitis may result.

Three cases of acute cholecystitis associated with the presence of pancreatic ferments in the gallbladder bile are reported.

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SURGERY OF THE GALLBLADDER AND BILIARY TRACT

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A THOROUGH study has been made of 360 consecutive cases of non-malignant diseases of the gallbladder and biliary tract treated at the New York Hospital from September 1, 1932, to January 1, 1935. There is presented for consideration in this review: (1) A brief discussion of the problems which were presented. (2) A detailed description of the method employed in exploring and draining the common duct. (3) An outline of the policy of the treatment of acute cholecystitis. (4) A summary of the hazards encountered in biliary tract surgery, as evidenced by an analysis of the deaths in this series of cases.

(1) STATISTICAL RÉSUMÉ.—Certain clinical facts were noted from the study of the histories of this group of patients. Gallbladder and biliary tract diseases occur more frequently in women than in men, a ratio of 4 to 1. Eighty per cent of the women afflicted associated the onset of symptoms with their first pregnancy. The age of the patients ranged from 8 to 81 years; the largest number, however, were between 40 and 50 years of age. The duration of symptoms varied from a very short time, as in an initial attack, to 40 years; the average duration was five years. The classic symptoms of gallbladder disease occurred in the following order of frequency: (a) belching, (b) attacks of colicky pain, (c) intolerance of fatty foods, (d) attacks of nausea, (e) attacks of vomiting and (f) jaundice.

An exhaustive physical examination was made in every case. Abnormal findings were investigated further by special methods; the cardiovascular and renal systems were carefully checked; renal function and blood urea determinations were made to confirm the clinical findings. If these examinations revealed impaired function of any system, an effort was made to repair the damage before operation in order to avoid postoperative complications. Upper respiratory infections were treated by rest in bed and local therapy unless the surgical condition demanded immediate operation. The dental therapist was called upon to correct infection in the mouth, which is a contributing factor in some of the postoperative pulmonary complications. Postoperative distention was forestalled by thorough evacuation of the gastrointestinal tract. It was evident in these cases that a favorable fluid balance and a good glycogen reserve protected the patient during anesthesia and operation. Roentgenography was not employed as a routine diagnostic measure; however, in the cases in which it was used the diagnosis was correct in 90 per cent.

The series of 360 cases of non-malignant diseases of the gallbladder and

biliary tract included 305 cases of acute, subacute or chronic cholecystitis treated by cholecystectomy with six deaths (1.9 per cent); 42 cases of common duct obstruction due to stone associated with acute or chronic cholecystitis treated by cholecystectomy plus choledochostomy or cholecystostomy plus choledochostomy with four deaths (9 per cent); eight cases of acute or subacute cholecystitis treated by cholecystostomy with no deaths; and five

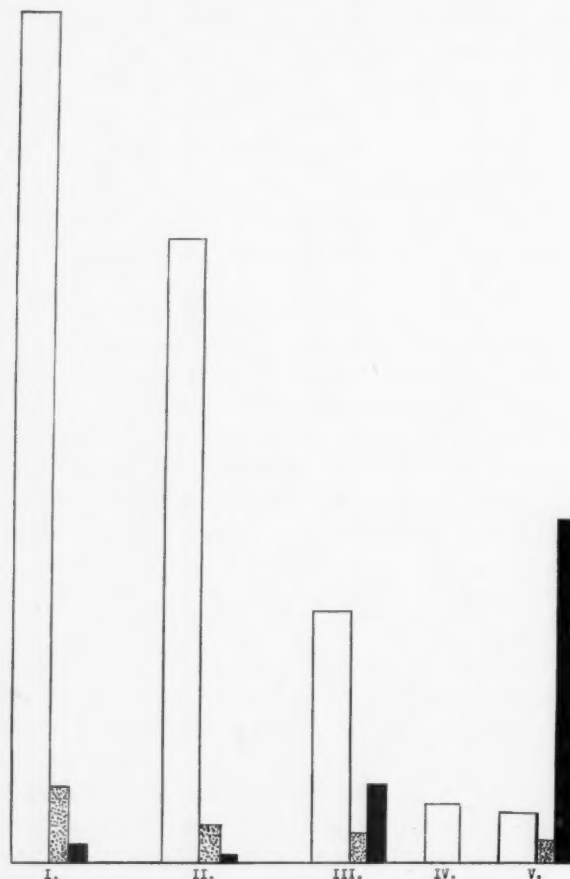


CHART I.—Non-malignant diseases of the gallbladder and biliary tract. (I)—Total 360 cases, 12 deaths, mortality 3.3 per cent. (II)—Three hundred and five cases treated by cholecystectomy, six deaths; mortality 1.9 per cent. (III)—Forty-two cases treated by cholecystectomy or cholecystostomy with choledochostomy, five deaths; mortality 9 per cent. (IV)—Eight cases treated by cholecystostomy, no deaths. (V)—Five cases of common duct obstruction following previous operation, treated by plastic operations on the common duct, two deaths; mortality 40 per cent.

cases of common duct obstruction following previous cholecystectomy with long-standing jaundice, treated by plastic operations upon the common duct with two deaths (40 per cent). The total mortality for the 360 cases was 3.3 per cent (Chart I).

(2) INDICATIONS AND METHODS FOR EXPLORATION OF THE COMMON DUCT.—Lahey¹ states that "the ducts should be opened and searched for stones whenever the gallbladder is found thickened or contracted." We do not believe that the common duct should be explored routinely because it is a formidable procedure, adding definitely to the postoperative burden and sometimes to the mortality rate. We feel that exploration of the common duct should be reserved for cases (a) in which there are stones palpable in the duct; (b) in which there has been a history of progressive jaundice or repeated attacks of jaundice; (c) in which the common duct is dilated and (d) in which the head of the pancreas is indurated. Induration of the head of the pancreas is often associated with obstruction due to stones in the ampulla of Vater and should be considered an indication for, rather than against, exploration. The indurated common duct found in acute and sub-acute inflammatory processes of the gallbladder and which is associated with only a mild degree of jaundice (icteric index of 30 or less) should not be molested, for it seldom contains stones. If the duct is distended, as well as indurated, the situation is altered. Patients with cholecystitis and cholelithiasis, giving histories of repeated attacks of jaundice, should be explored with particular care not to overlook stones; it is in these cases that exploration has revealed stones in the hepatic ducts. In reviewing the autopsy findings in the 12 deaths, we found two instances in which stones in the common duct had been overlooked at operation. Unfortunately, this is not an uncommon experience in surgery of the common duct and any method which tends to eliminate it should be employed. We have found the Cameron light of distinct value in meeting this problem. The procedure is as follows: An incision is made in the common duct just below the entrance of the cystic duct, sufficiently large to admit such instruments as may have to be introduced (2 to 3 cm.). One traction suture of silk is placed on each side of the opening in the wall of the common duct to facilitate visual inspection of its lumen. When the thickness of the wall, and the degree of induration and distention have been estimated, a small Cameron light is introduced and passed downwards toward the duodenum. If there is an obstruction, its position can be determined and because of the difference in density of stones and the duct, the stones will be clearly outlined, enabling one to determine the nature of their surface. With the light in the duct, an attempt can be made by manipulation to express the stone upwards. If this does not meet with success, it may be possible to remove the stone with a forceps or probe. Some soft stones break into pieces and can be removed piecemeal. This procedure, however, is dangerous because it may injure the wall of the duct, and inadvisable because of the possibility of failing to remove all the fragments. A catheter introduced into the common duct will frequently relieve the obstruction by dislodging the stone (Figs. 1 and 2).

When the obstruction has been relieved, the light is passed down to the ampulla of Vater; if there are stones in this region, they will be outlined against the less dense walls. This is an especially important procedure, be-

cause it is here that stones are most easily overlooked as it is possible to introduce a catheter past them into the duodenum and to irrigate around them without noting an obstruction.

The light is now removed and a catheter inserted through the cystic duct into the common duct to a point below the orifice through which we have been working. The cystic duct may require dilatation with a curved clamp

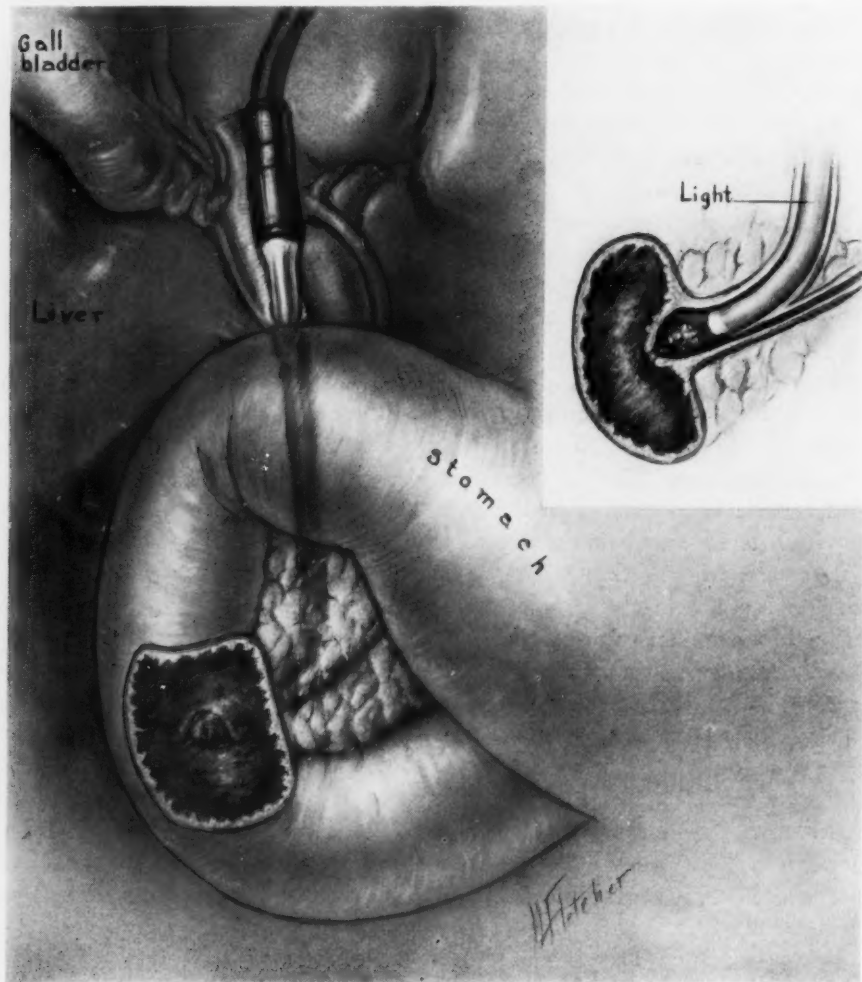


FIG. 1.—Exploration of the common duct facilitated by small electric light.

or a small dilator. The catheter should, however, fit the cystic duct snugly; its tip should lie above the ampulla of Vater. It is secured in this position by a ligature of plain catgut. The procedure terminates with the closure of the opening in the common duct (Fig. 2). This method of drainage of the common duct was described by Reid⁷ in 1920. Transection of the duodenum is obviously indicated when a large stone is impacted in the ampulla.

(3) ACUTE CHOLECYSTITIS.—There is a widely accepted opinion that the welfare of the patient with acute cholecystitis, on the whole, is best conserved by waiting for the acute process to subside and to then operate, if operation is contemplated, after the disappearance of the acute symptoms. The reasons set forth are based upon two premises: first, that the acutely inflamed viscus generally takes care of itself and that, therefore, complications due to gangrene and perforation do not occur; and second, that there is greater danger to the patient to undergo an operation during the acute stage of the inflam-

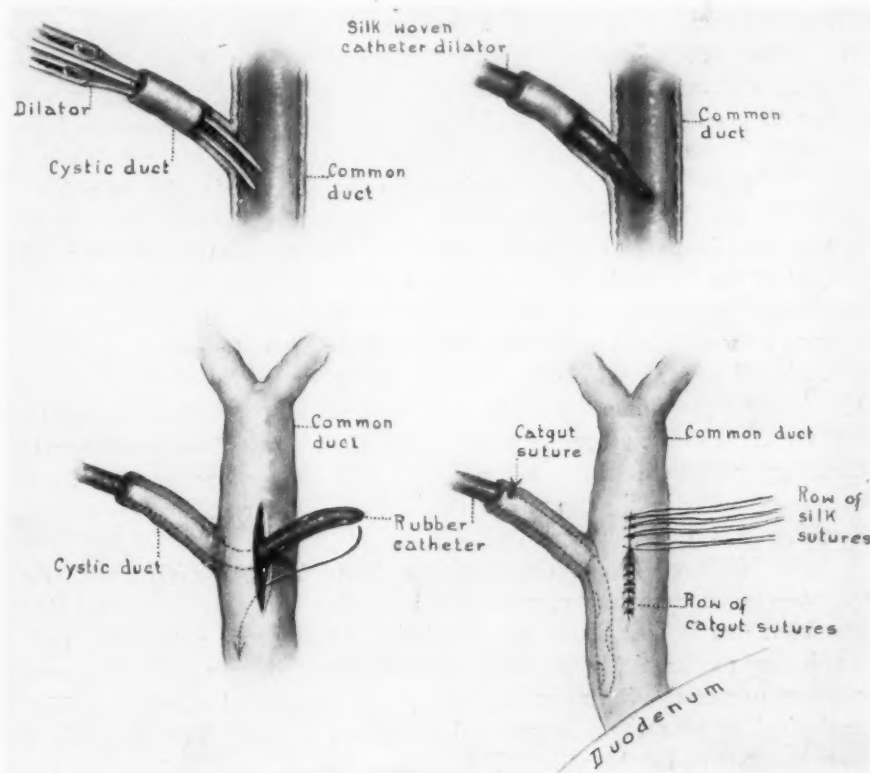


FIG. 2.—Drainage of the common duct through the cystic duct.

matory process than during an interval or chronic stage. As to the first supposition, it may be said that the majority of cases of acute cholecystitis do subside; however, those that do not contribute in large measure to the high mortality in the surgical treatment of this disease. The second assumption, that there is increased danger to the patient from an operation during the acute stage of the disease, is not borne out in our experience. In 80 cases of acute cholecystitis treated in the early stages, there were four deaths (5 per cent). It will be seen that this mortality is no higher than the mortality rate for cholecystectomy in chronic cholecystitis and cholelithiasis. A study of the literature shows that these figures compare well with those of

many other clinics. We believe that most surgeons will agree with the statement that the acutely inflamed gallbladder may be removed more easily than the chronically inflamed viscus, and the postoperative course is no more stormy.

The danger of gangrene and perforation of the gallbladder in acute cholecystitis cannot too strongly be emphasized. In this series of acute cases, 80 in number, there were 12 instances of perforation (15 per cent). Heuer² in a review of the records of 800 patients with gallbladder and biliary tract disease treated in the old New York Hospital found that 21 per cent of the acute cases operated upon showed evidence of perforation. Zininger³ reports an incidence of 20.5 per cent; and Morris Smith⁴ 22.4 per cent. There are other observers whose statistics substantiate our estimate that between 15 and 20 per cent of all cases of acute cholecystitis show evidence of perforation. These are the cases which develop the associated conditions of abdominal abscess, liver abscess and peritonitis, which raise the mortality in gallbladder and biliary tract surgery.

(4) THE HAZARDS IN GALLBLADDER AND BILIARY TRACT SURGERY.—An analysis of the 12 deaths in this series of 360 cases shows that there are six factors which are chiefly responsible for the mortality. It is hoped that a study of these may lead to a better understanding of, and a safer approach to, cases of gallbladder and biliary tract disease. The causes of death will be discussed under the following headings: (1) Errors in technic and complications traceable to the operative procedure; (2) cardiorenal disturbances; (3) pulmonary complications; (4) jaundice; (5) acute cholecystitis and its immediate complications, gangrene and perforation of the gallbladder and (6) liver damage, insufficiency and liver death.

Errors in Technic and Complications Traceable to the Operative Procedure.—There were four cases in the series in which death may be said to have been due in part to errors in technic. In one case autopsy showed a local biliary peritonitis, in one a chronic subphrenic abscess and in two cases, postmortem examination revealed stones in the common duct which had been overlooked at operation. A method by which we may hope to avoid the latter occurrence has been described. The cause of death in the first cases can best be eliminated by slow meticulous performance of the operative procedure, with the least possible injury to the organs and tissues, with careful control of hemorrhage and the prevention of soiling of the peritoneum by adequate protection.

Cardiorenal Disturbances.—In a recent publication Heuer² emphasizes the importance of cardiorenal disturbances as a factor in the deaths in gallbladder and biliary tract surgery. He points out that 12 per cent of the mortality in a large series of cases taken from the literature could be accounted for by associated cardiorenal disease. In the small group of cases herein reported, cardiorenal disturbances seem to have led to a far higher percentage of fatalities, in fact 50 per cent of the deaths may be attributed to an impaired cardiorenal system. Marked arteriosclerosis alone seems to

add to the hazard of gallbladder surgery; seven patients were definitely arteriosclerotic. If arteriosclerosis is associated with definite hypertension, and six of the patients had a diastolic blood pressure of over 90, we have just reason for hesitancy in operating. Renal damage with albuminuria and increased blood urea nitrogen retention accompanying arteriosclerosis and hypertension becomes a very serious contra-indication to operation. The problem presented by patients of this type is not easy to solve, for there is an unexplained interaction between these disturbances and the disease which we are discussing. We know that the type of individual who is constitutionally prone to gallbladder disease is also subject to arterial hypertension, arteriosclerosis and myocarditis. In addition, chronic cholecystitis appears to predispose to cardiorenal disturbances. The combined efforts of physician and surgeon are required to deal with the preparation of such patients for operation. The most satisfactory results have been obtained with rest in bed, regulation of fluid intake and digitalization when indicated.

Pulmonary Complications.—Of the 12 patients who died following gallbladder surgery, seven were reported to have had pulmonary complications such as pneumonia, atelectasis and purulent bronchitis. We find it difficult to evaluate the importance of these findings. Patients with cardiorenal disturbances frequently die of a terminal pneumonia; but the pneumonia can be considered no more than a contributing factor in the death of these cases, for it is not always associated with the anesthesia nor with disease of the respiratory system. Frank postoperative pulmonary complications may be best avoided by the careful administration of inhalation anesthesia. Postoperative hyperventilation of the lungs by means of carbon dioxide and oxygen may be of value. The use of local or spinal anesthesia does not appear to materially reduce pulmonary complications.

Jaundice.—The observation that long-standing jaundice is associated with general debility and a tendency to hemorrhage was confirmed in this series of cases. Jaundice was present in seven of the patients who died; five of the seven had had biliary obstruction for a relatively long period of time; four died of hemorrhage.

The preoperative treatment of the patient with jaundice is far from satisfactory. An effort should be made to build up the patient's resistance to infection. This may be accomplished in part by intravenous administration of glucose and calcium salts with an adequate fluid intake. Small transfusions have been used with some benefit, but the hazard of operation in the presence of jaundice still remains high.

Acute Cholecystitis and Its Immediate Complications, Gangrene and Perforation of the Gallbladder.—One of the series of 12 deaths occurred in a patient with acute gangrenous cholecystitis complicating typhoid fever. Two cases of acute cholecystitis with histories of recurrent attacks associated with common duct obstruction died of localized peritonitis and abscess formation. In the experience of the surgeons who have contributed to the literature in the past decades, the complications of acute cholecystitis are largely pre-

ventable by operation in the early stages of the disease, before such complications have arisen.

Liver Damage, Insufficiency and Liver Death.—There was one death in the series which closely resembled what Dr. Heyd⁵ has termed "liver death." The patient had been jaundiced for a long time. Unfortunately, an autopsy was not obtained. Two patients gave evidence of impaired hepatic function before death, who prior to operation had satisfactory functional tests. Both cases, however, had cardiorenal disease and jaundice.

At the present time the causes of impaired hepatic function are not known. The iso-iodokan test devised by Graham⁶ is used to confirm our suspicion of impaired function. As a corrective measure, glucose is administered pre- and postoperatively; in addition, calcium salts are given but their value is not definitely known.

By reviewing the deaths which have occurred in this group of cases, we can appreciate the hazards incident to gallbladder and biliary tract surgery. Even with full recognition of the dangers involved, we must, however, at times operate upon patients who are not good surgical risks; seven of the 12 patients who died were observed over a period of three days before operation, and every method at our disposal was employed in an attempt to improve their condition preoperatively. Many of the successful cases were not good risks, but we cannot withhold surgical treatment even in cases in which operation is a serious hazard, if this is the only means of curing them of the disease.

SUMMARY AND CONCLUSIONS

(1) Three hundred and sixty cases of non-malignant diseases of the gallbladder and biliary tract are reported in which operation was followed by a mortality of 3.3 per cent. The mortality for cholecystectomy alone was 1.9 per cent; when combined with exploration and drainage of the common duct, cholecystectomy or cholecystostomy was attended by a mortality of 9 per cent. Secondary plastic operations, fortunately rarely necessary, led to a very high mortality (40 per cent).

(2) Exploration of the common duct should be carried out with great care in cases in which it is indicated. The use of a small Cameron light is advocated and the procedure is described.

(3) Acute cholecystitis should be treated in an early stage of the disease to escape the complications which contribute to the mortality.

(4) An analysis of the deaths in this series of cases shows that the chief causes of mortality in gallbladder and biliary tract surgery are an impaired cardiorenal system, jaundice and a damaged liver.

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APPENDICITIS

AN ANALYSIS OF 4,833 CASES

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OPERATIONS for acute appendicitis constitute the most frequent major surgical procedure in our hospitals today. The laity consider themselves better informed on the symptomatology and treatment of appendicitis than any other surgical condition. It is therefore startling to be informed through life insurance statistics that the mortality rate of appendicitis has markedly increased in the past 20 years, a period in which surgery has made so many advances. The degree of professional dissatisfaction may be indicated by the fact that in the past four years over 800 articles on appendicitis have been published in our medical journals. Miller¹ aptly terms the death rate "a menace to humanity, a disgrace to the medical profession and a challenge to us who claim to practice the science and art of surgery."

A survey of published statistics reveals a wide variation in mortality rates depending upon the methods of classification, the types of cases, and the variations in treatment. Mortality rates based upon vital statistics universally show an increase in the past 20 years. The Metropolitan Life Insurance Company² shows that the mortality rate for acute appendicitis rose from 10.6 per 100,000 for 1911 to 1914, inclusively, to 14.1 per 100,000 for 1927 to 1930, inclusively, and estimates that during recent years there have been approximately 25,000 to 30,000 deaths annually in the United States compared with 16,000 to 18,000 20 years ago. Adams,³ quoting the Registrar General's statistics, shows that the mortality rate in England has risen from 69 to 74 per 1,000,000 between 1913 and 1923. It is to be stressed that these statistics are based upon total deaths per unit population and not upon actual case reports, thus not indicating the incidence of this infection.

Walker² believes that in reality there exists an increased incidence, as well as an increase due to greater scientific knowledge and diagnostic skill. Statistics show a universal increased incidence of operations for appendicitis. Walker,² in 1934, compiled comparative statistics from literature for the two periods 1900 to 1915 and 1916 to 1932 and found that the general operative mortality in the latter period was about 2.5 per cent less than that of the first period. There are many published comparative mortality rate statistics^{2, 4} which show a decreased operative mortality in recent years. We may therefore rightfully conclude that while the mortality rate in appendicitis based upon vital statistics has been gradually rising, the mortality based upon operations for appendicitis has been gradually falling. Notwithstanding

APPENDICITIS

this conclusion, however, acute appendicitis and its complications remains a challenge to the medical and surgical profession.

The analysis of the cases presented in this paper is based upon all cases of acute appendicitis that were operated upon, or that died without operation, on the various Surgical Services at the Methodist Episcopal Hospital, Brooklyn, from January 1, 1924, to January 1, 1934, inclusively. It does not include those cases which, while diagnosed as acute appendicitis, were not operated upon for various reasons and either recovered or having signed a release went elsewhere, and the ultimate outcome is unknown. It should be mentioned that a high majority of our cases are brought into the hospital by our ambulances which are maintained by the municipal government for the care of those unable to afford private physicians. Because of the physical and financial condition of these people, we receive a large percentage of poor operative risks and mismanaged or neglected cases. This can be fully appreciated only by those who have had similar experiences in treating these cases from the poorer sections of any large metropolitan city.

Table I is a complete analysis by years of all cases of appendicitis, divided into acute, chronic and prophylactic (those removed at the time of laparotomy for some other condition) and their mortality rates. During the ten year period 1924 to 1934, inclusive, there was a total of 4,791 operations for appendicitis with an operative mortality rate of 2.03 per cent. This included 2,260 cases of acute appendicitis with an operative mortality of 4.3 per cent; 1,368 cases of chronic appendicitis with a mortality of 0.58 per cent and 1,205 prophylactic appendectomies without a death attributable to

TABLE I
Summary of Cases with General Mortality by Years

Year	Total Appen- dectomies	Acute Appendicitis			Chronic Appendicitis			Prophy- lactic Appen- dectomies
		Total	Deaths	Mortality Rate %	Total	Deaths	Mortality Rate %	
1924.....	409	209	8	3.8	90	1	1.1	115
1925.....	361	166	4	2.4	100	0	0	95
1926.....	416	191	9	4.9	111	1	0.9	118
1927.....	435	202	12	5.9	128	1	0.8	106
1928.....	466	240	10	4.1	132	0	0	102
1929.....	551	252	12	4.8	167	0	0	138
1930.....	527	235	15	6.3	203	3	1.4	95
1931.....	596	266	11	4.1	113	0	0	220
1932.....	495	220	9	4.1	185	2	1.8	94
1933.....	535	279	12	4.3	139	0	0	122
Totals.....	4,791*	2,260	102	4.3 average	1,368	8	0.58 average	1,205

* Five died without operation. General mortality of both acute and chronic types 2.03 per cent.

this phase of the operation. It is apparent that in more recent years there has been a slightly increased incidence of acute cases, but the mortality rates of all types have shown only mathematical variation. The author has included under fatal cases all those cases which died during convalescence whether directly associated with the appendicitis or not.

Table II shows the incidence and mortality of the acute cases according to the pathologic diagnosis, 28 per cent of the cases being acute catarrhal or acute exacerbation of a chronic appendicitis with a mortality rate of 0.31 per cent, these two deaths being due to poliomyelitis—bulbar type, and pulmonary embolism, respectively. Thirty-nine per cent of the cases were acute suppurative or gangrenous without perforation or gross peritonitis with a mortality of 0.8 per cent. Of these seven deaths, four were due to lobar pneumonia, and one each due to gas gangrene of the abdominal wall, intestinal obstruction and general peritonitis. Eighteen per cent of the cases were acute suppurative or gangrenous, complicated by spreading peritonitis with a mortality rate of 4.8 per cent. In the correct diagnosis of the exact pathology in any case, there is a factor of variation. Our technical judgment demands minimal incision and manipulation, thereby lessening our opportunity to learn the extent of the peritoneal reaction. In reviewing these cases, the author was impressed by the many cases of acute suppurative and gangrenous appendicitis in which no rupture had occurred, the peritoneal fluid was only turbid and there was no macroscopic suppuration. The operator invariably diagnosed these as free from local or spreading peritonitis, yet, not infrequently, the cultures of this free fluid gave positive growths of intestinal flora and the pathologist reported multiple abscesses in the meso-appendix and serosa. Certainly a spreading peritonitis must have existed in many of these cases at the time of operation although it was not diagnosed and is not so classified here. Seven per cent of the acute cases showed definite localization and abscess formation with an operative mortality of 5.3 per cent. 9.2 per cent of the cases demonstrated diffuse generalized peritonitis with a mortality rate of 31 per cent. It is noteworthy that 23.1

TABLE II
Incidence and Mortality According to Pathologic Diagnosis

Type	Total	Incidence %	Deaths	Mortality Rate %
Acute catarrhal or acute exacerbation of chronic appendicitis.....	633	28	2	0.31
Acute suppurative or gangrenous appendicitis.....	872	38.6	7	0.80
Acute suppurative or gangrenous with spreading peritonitis.....	396	17.5	19	4.79
Acute suppurative or gangrenous with local abscess..	150	6.6	8	5.3
Acute suppurative or gangrenous with diffuse peri- tonitis.....	209	9.2	66	31
23.1 per cent perforated at time of operation.				

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per cent of our cases of acute appendicitis had ruptured by the time of operation. This is a higher incidence than nearly all other published statistics, Finley⁵ reporting 18 per cent in 3,913 cases. The incidence of the various pathologic types showed only slight yearly variation, the statistics for the last five years showing that, despite public education, our percentage of complicated cases was even slightly higher than in the first five years of this analysis.

These statistics compare favorably with those of Black⁶ who, in 1932, reviewed statistics as presented by 52 reporters in this country and abroad including 150 hospitals, 1,500 surgeons and 83,144 cases. There existed a wide variation, but the following are the average mortality rates according to the pathologic diagnosis:

Chronic.....	0.99 per cent
Acute.....	4.5 per cent
Suppurative.....	7.87 per cent
Gangrenous.....	8.73 per cent
Spreading peritonitis.....	21.19 per cent
Basic average.....	5.5 per cent

Sex.—An analysis of the incidence and mortality by sex revealed 48 per cent were males with 61 per cent of the deaths compared with 52 per cent of females with 39 per cent of deaths, showing almost equal incidence, but a greater mortality in the males. An analysis of the incidence by month and season showed a negligible variation.

Age.—An analysis of the incidence and mortality rate by age is interesting (Graph I). The ages in this series ranged from 12 months to 80 years. It is apparent that the greatest incidence was from 16 to 20 years (20 per cent); 72 per cent of all cases occurred between the ages of 6 and 30 with an average mortality rate of 1.8 per cent. Or from another viewpoint, 44 per cent of all deaths occurred under 11 and over 55, yet only 18 per cent of all cases occurred in these age groups.

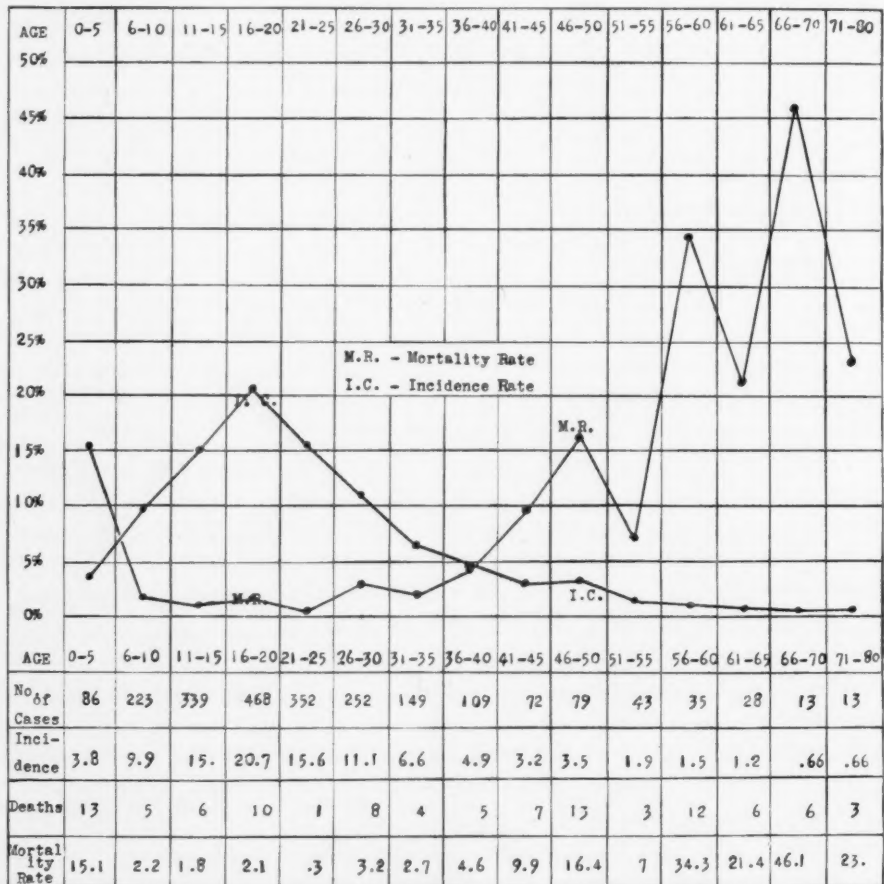
The higher mortality and lower incidence in children and elderly adults has repeatedly been discussed. The gravity of acute appendicitis in children is dependent not only upon the inherited virulence of the infection, but also upon the delay attendant upon the difficulties of diagnosis and upon the very frequent administration of drastic purgatives. All writers agree that appendicitis in children, as in adults, develops with marked rapidity once it has started. Maes, Boyce and McFetridge,⁷ in analyzing 250 cases below 12 years at the Charity Hospital, New Orleans, found that 73 per cent were complicated at time of operation by gangrene, rupture, abscess or peritonitis. Gallie found that 70 per cent of the cases of acute appendicitis in children admitted to the Toronto Children's Hospital entered with the appendix already ruptured. In the surgical treatment of appendicitis in children, it is better to operate upon a suspected case and find a normal appendix than fail to operate until the diagnosis is unmistakable and the prognosis grave.

Maes,⁷ in an analysis of 100 cases over 40 years of age, found that 77

per cent at the time of operation were complicated by gangrene, rupture, abscess or peritonitis and the operative mortality was 21 per cent. Wood,⁸ in discussing acute appendicitis in the aged, found "atypical clinical manifestations in 50 per cent, correct preoperative diagnosis in only 62 per cent and 28 per cent mortality, one-half of which were due to operative complications in the aged and one-half to complications due to the appendicitis *per se*."¹¹

GRAPH I

Incidence and Mortality by Age



Delay.—It is universally agreed that the two greatest factors in the existing mortality rate for acute appendicitis are the time interval between the onset of symptoms and operation, and the administration of cathartics, the former being more important since any delay and mismanagement implies usually some treatment and the laity have not yet learned the danger of treating abdominal pain with cathartics. Bailey¹ found a mortality rate of less than one per cent among those operated in the first 12 hours, the rate

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rising to 18 per cent in those in which there was a delay in operation to 36 hours or over. Bower,⁹ in his widely known Philadelphia survey, found similar results. In our series those cases showing suppurative, gangrenous or complicated pathology were analyzed to determine the incidence and mortality according to the preoperative delay (Table III). The cases of acute catarrhal appendicitis and acute exacerbation of chronic appendicitis were not included because many of these cases presented minimal symptoms for many days and if included would obscure the ultimate conclusion.

TABLE III
Incidence and Mortality Based upon Preoperative Delay

1924-1933	0-12 hours	12-24 hours	24-36 hours	36-48 hours	48-72 hours	72-96 hours	5 days and over
Total.....	212	411	134	296	221	86	225
Incidence.....	13.4%	25.9%	8.4%	18.6%	13.9%	5.4%	14.2%
Deaths.....	4	10	4	24	19	9	32
Mortality rate.....	1.8%	2.4%	3%	8.1%	8.6%	10.5%	14.2%

It is at once apparent that delay is attended with marked increase in mortality. Over a ten year period only 13 per cent were operated upon within 12 hours of the onset of symptoms with a mortality rate of 1.8 per cent. Many cases, especially those with the obstructive type of appendicitis with its characteristic rapid clinical picture, are complicated within 12 hours. One of our cases was ruptured after a duration of only four hours. It is noteworthy that from 1929 to 1934, 43 per cent were operated upon within 24 hours with a mortality of 1.7 per cent compared with 33.3 per cent in the period 1924 to 1929 with a mortality of 2.1 per cent. This shows some progress in the right direction although not nearly so marked as that noted in Philadelphia following the recent extensive public health educational program.¹⁰

On the other hand, over 15 per cent of our cases had a preoperative duration averaging eight days, with a mortality of 14.2 per cent. It is noteworthy that there has been no reduction in recent years in these markedly delayed cases. The fact that 83 per cent of all our deaths occurred in cases with a preoperative delay of over 36 hours indicates this danger.

In reference to cathartics, Bowers,¹⁰ in analyzing the mortality records of 28 Philadelphia hospitals from 1928 to 1930, showed that of those taking no cathartic during the acute attack, one in 80 died; with one cathartic, one in 13 died; and of those that took two or more cathartics, one in seven died. In our own series, a history of cathartics was obtained in only 10 per cent of all cases, and 32 per cent of the fatal cases. With no cathartics, one in 28 died; with a history of one cathartic one in seven died; with a history of two or more cathartics, one in five died. Since those cases having taken one or more cathartics are usually also those cases in which extensive preoperative delay occurred, the exact danger of the cathartics cannot be evaluated although there can be no doubt but that the marked peristalsis induced by

cathartics in the presence of a tense suppurative or gangrenous appendix favors rupture, or in the presence of spreading peritonitis, favors dissemination of the infection.

Surgical Technic.—The proper surgical procedure in acute appendicitis involves many debatable points and deaths occur in every series of cases which probably could in small part have been prevented by different technic, but one should always recall that the outcome in any case or group of cases depends not so much upon the exact procedure adopted as the promptness with which it is adopted and the wisdom which correlates the pathologic process present with the extent of the surgery performed. Accordingly, the surgeon's judgment is as important as his technical skill.

In this series of cases, almost universally, operation was performed as soon as possible after the diagnosis was made. It was deferred in a few critical cases and hypodermoclyses, venoclyses and general supportive treatment given until the patient's general condition was sufficiently improved to permit surgery, but we have not followed the Ochsner treatment which in the hands of many has apparently given such satisfactory results. Le Grand Guerry,¹¹ in a very commendable series, reports a mortality of 1.6 per cent in cases of acute diffuse peritonitis in which operation was deferred (Ochsner treatment being used) compared with a mortality of 8.2 per cent in cases of acute diffuse peritonitis with immediate operation. Coller and Potter,¹³ in a recent article, show a mortality of 9.3 per cent in cases of acute diffuse peritonitis under Ochsner treatment. I believe that with the exception of acute appendicitis in children, the general condition of the patient is the best indication of the proper time to operate. In cases of acute diffuse peritonitis, a delay of several hours during which supportive treatment is given certainly improves the patient's risk, yet I believe that our mortality rate would be somewhat reduced if, in selected cases, the Ochsner treatment were instituted.

In this series, general inhalation anesthesia (gas-oxygen-ether) was almost universally used, there being 2,130 such cases. Spinal anesthesia was used in 111 cases during the last four years. There have been no deaths or apparent complications due to the use of this type of anesthesia in these cases and in many of the acutely ill, especially in elderly people, it has been markedly superior. Novocaine as a local anesthesia was used in 12 cases, avertin basal in three, and amytal basal (gr. xv) in four cases. In respect to anesthesia, each case offers its own indications or contraindications, but, in general, we believe the general inhalation anesthesia to be preferable, with spinal anesthesia of great value in selected cases.

In 71 per cent of these cases, the small McBurney incision was used, 28 per cent right rectus incision and 1 per cent midline incisions. In our experience, the McBurney incision reduces the operative time, permits adequate exposure (the incision being enlarged to a right rectus incision in the hockey stick manner if necessary), limits intraperitoneal manipulation and markedly reduces the incidence of postoperative hernia. We have never seen a post-

operative hernia in an undrained McBurney incision and in drained cases (30 per cent) there was a reported incidence of hernia in 0.9 per cent with the McBurney incision compared with 2.7 per cent with right rectus incision, an incidence three times as great.

In respect to drainage of the peritoneal cavity, excluding definite abscess formation, the attitude in recent years has changed from "when in doubt, drain," to "when in doubt, don't drain." Drainage lengthens the period of hospitalization and increases postoperative complications, such as hernia, fistula, adhesions and intestinal obstruction. At best, drains care only for localized areas, never the general peritoneal cavity. In our series, we use multiple drains at times. Soft rubber tubes, glass tubes, gauze and cigarette drains are the common materials employed. Occasionally, the rubber and glass tubes are aspirated regularly with sterile catheters. It has been our practice to enter the peritoneal cavity through the smallest possible incision, explore digitally, exteriorize the appendix if possible, clamp and tie the meso-appendix, ligate the appendix at its base, sever it with actual cautery and invert the stump with chromic or linen suture, approximating the severed meso-appendix stump to the appendiceal area and routine layer closure. If the appendix cannot be delivered into the wound or if rupture and peritonitis exist, the incision is made adequate, the operative area protected by laps and the appendix removed in the easiest manner, often being "backed out." Peritoneal fluid, exudate or pus is sponged or aspirated, the pelvis and lateral gutter being sponged or aspirated for collections of fluid. In recent years only those cases are drained in which there is macroscopic purulent fluid or cases in which inflammatory necrotic tissue will probably form a slough, or in which considerable oozing is contemplated. Frequently, multiple drains are used, often of combined types and often by separate stab wounds to the pelvis and lateral paracolic gutter. In cases of abscess formation or diffuse generalized peritonitis, the appendix is removed if accessible with only moderate difficulty. We agree with Quain and Waldschmidt¹⁴ that "when the cause is removed, the patient has a better chance to overcome the damage already wrought on the peritoneum" except when its removal may cause the tragedy of the conversion of a localized abscess into a generalized peritonitis by the breaking down of protective adhesions. In these latter cases, *i.e.*, appendiceal abscess in which appendectomy may not be easily performed, drainage only is instituted and secondary appendectomy later performed. As seen in Table IV, 41 such cases were operated upon, with a mortality of 9.7 per cent, and of these there were 11 recorded secondary appendectomies without a single death. McGrath and Eiss¹⁵ have recently reviewed this attitude both pro and con and believe that "in acute appendicitis, it is not enough to merely save life; the aim should be to restore the patient to complete health and efficiency with as little delay as possible" and advise dissection and removal of the appendix even under the most unfavorable conditions.

TABLE IV
Mortality According to Operative Procedure

Procedure	No.	Mortality	
		Deaths	Rate %
Appendectomy.....	1,580	10	0.63
Appendectomy with drainage.....	630	75	11.9
Drainage of abscess only.....	41	4	9.75
Drainage and enterostomy.....	1	1	100
Appendectomy with drainage and enterostomy.....	8	7	87.5
Died without operation.....	—	5	—

(No essential difference by years.)

In the selection of drainage material, there exists a marked divergence of opinion. McGrath and Eiss¹⁵ employ rubber tissue, avoiding rubber tubing since it is liable to produce a fecal fistula, and believe gauze is unsatisfactory because, instead of draining, "it blocks drainage and thus encourages multiplication of infection." On the other hand, Arnheim and Neuhof⁴ use iodoform gauze with rubber tissue and have very appreciably lowered their mortality.

The attitude towards drainage will probably change radically in the next decade. Muller¹⁶ does not drain for turbid fluid even if spreading peritonitis exists. Some surgeons in cases of diffuse peritonitis merely insert non-absorbable metal sutures including all layers, not tying until drainage ceases; others close the peritoneum but drain the fat layer. The results of this new procedure will be of interest.

In respect to cultures of the peritoneal fluid, Muller¹⁶ states that "they are unreliable for exact diagnosis and unnecessary, because of the great amount of work required for proper study." Meleney¹⁷ found "B. coli, green streptococci and B. welchii the organisms most commonly found but there seemed to be no association between the type of organism and the severity of the lesion, but rather it is the dosage of those organisms and the presence of irritating intestinal juices that determines the fatal outcome."

Appended is a summary of the causes of death in the cases of both acute and chronic appendicitis.

Acute appendicitis—Total deaths.....	102
Generalized peritonitis.....	52
General peritonitis and intestinal obstruction.....	8
Intestinal obstruction without peritonitis.....	2
Cardiac decompensation with peritonitis.....	4
Cardiac decompensation without peritonitis.....	9
Intramural thrombosis (autopsy).....	2
Lobar pneumonia.....	12
Bronchopneumonia.....	1
Pulmonary TBC (pelvic abscess).....	1
Pulmonary embolism.....	6
Empyema (general peritonitis).....	1
Suppurative pyelophlebitis (liver abscess).....	1

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Poliomyelitis.....	1
Diabetes with general peritonitis.....	1
Gas gangrene of abdominal wall.....	1
Chronic appendicitis—Total deaths.....	8
General peritonitis.....	2
Lobar pneumonia.....	3
Bronchopneumonia.....	1
Pulmonary embolism.....	1
Intestinal obstruction (enterospasm—autopsy).....	1

It is to be noted that 65 per cent died of intraperitoneal suppuration and 35 per cent of some distant complication. Five of these deaths occurred without operation; 19 died within 24 hours of operation of peritonitis; and five died over three weeks after operation, one of lobar pneumonia, uremia and diabetes mellitus,—one of empyema and peritonitis on the thirtieth day, one of cardiac decompensation and bronchopneumonia on thirty-fifth day, one of pulmonary tuberculosis and pelvic abscess on forty-ninth day, and one of lobar pneumonia on the eighty-sixth day postoperative. Four deaths were associated with pregnancy. The following summary of the cases complicated by this condition is interesting:

	First Trimester	Second Trimester	Third Trimester
Pregnant.....	14	7	5
Recovered.....	13	5	4
Abortion.....	4	3	1
Died.....	1	2	1

Among the postoperative complications, the following are noteworthy:

Undrained cases: abscess formed which necessitated secondary drainage—four cases. General peritonitis occurred in two cases.

Drained cases: abscess formed which necessitated secondary drainage—nine cases. Fecal fistula occurred in eight cases (0.3 per cent). Phlebitis occurred in ten cases (0.4 per cent).

SUMMARY

The author has reviewed 4,791 consecutive appendectomies from 1924 to 1934, inclusive, including 2,260 cases of acute appendicitis, analyzing these in various aspects and briefly summarizing the recent literature in respect to the individual points analyzed.

The mortality rate in acute appendicitis, based upon vital statistics, has been gradually rising, but the mortality rate based upon hospital surgical case reports has been gradually falling, although it still constitutes a challenge to the medical and surgical profession.

The two greatest preventable factors in this mortality are the delay in operation and the administration of cathartics. The laity need to be further impressed that the ice bag has no influence on pathology and that it may be dangerous to administer cathartics in cases of abdominal pain.

There exist many debatable factors in the surgical technic employed in cases of acute appendicitis, the solution of which will partially reduce the

existing high mortality rate, but the outcome in any case or group of cases depends not so much upon the exact surgical procedure adopted as upon the promptness with which it is adopted and the wisdom which correlates the pathologic process present with the extent of the surgery performed.

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TREATMENT AND ANALYSIS OF EIGHTY-FOUR CASES

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THE following study is an analysis of eighty-four cases of congenital malformation of the brain and spinal cord associated with defects of the cranium and vertebral column. The material is taken from the Children's Surgical Service at Bellevue Hospital covering a period of fifteen years from 1919 to 1934. These cases are reviewed in order to correlate the clinical findings with the subsequent course, to ascertain the proper selection of cases for operation and the suitable operative procedure. Forty-seven or 56 per cent. of the patients were considered inoperable, of these thirty-three died within the first four weeks of life, thirteen died before the end of two months and only one was alive at the end of a year. Of the thirty-seven or 44 per cent. of the patients operated upon, ten died while in the hospital. Twenty-seven children survived the operation and have been followed from two months to ten years.

From a study of the literature there is apparently no unanimity of opinion as to the indication for operation, time to operate or correct operative procedure. These observations and conclusions with regard to the different varieties of spina bifida are made in the hope of adding greater clarity with regard to certain of the debated points in the management of this grave congenital affection. The gratification of the surgeon in treating this dreaded condition is in seeing some of these infants advance in years without physical or mental impairment or with but slight permanent handicap.

No case was considered inoperable unless the herniation ulcerated and cerebrospinal fluid exuded, or there was a progressively increasing hydrocephalus, or the patient was hopelessly crippled and deformed so as to render corrective procedure aimless. However, the presence of a slowly progressive hydrocephalus and an ulcerating tumor and leaking cerebrospinal fluid did not in all cases preclude operative intervention as illustrated by the following case report.

CASE I.—(Figs. 1A, 1B, 1C, and 1D.) Soon after birth, hydrocephalus increased simultaneously with the enlargement of a right-sided sacral myelomeningocele which was the size of a small grapefruit. More than half of the surface consisted of a tense, red, thin parchment membrane which ulcerated and subsequently discharged cerebrospinal fluid. With the escape of the latter the size of the head appreciably diminished. Following the closure of the sinus in the sacral protrusion the head increased in size, the fontanelles bulged and soon thereafter the parchment-like membrane ruptured and cerebrospinal fluid escaped. This sequence of events occurred four times within five months. For one month thereafter there was no further enlargement of the skull. The surface of the sac remained dry and no cerebrospinal fluid escaped. A Penfield-Cone

operation was performed, the entire dura and nerve filaments being reflected into the defect in the spinal column and covered with reflected fascia. For a period of two months

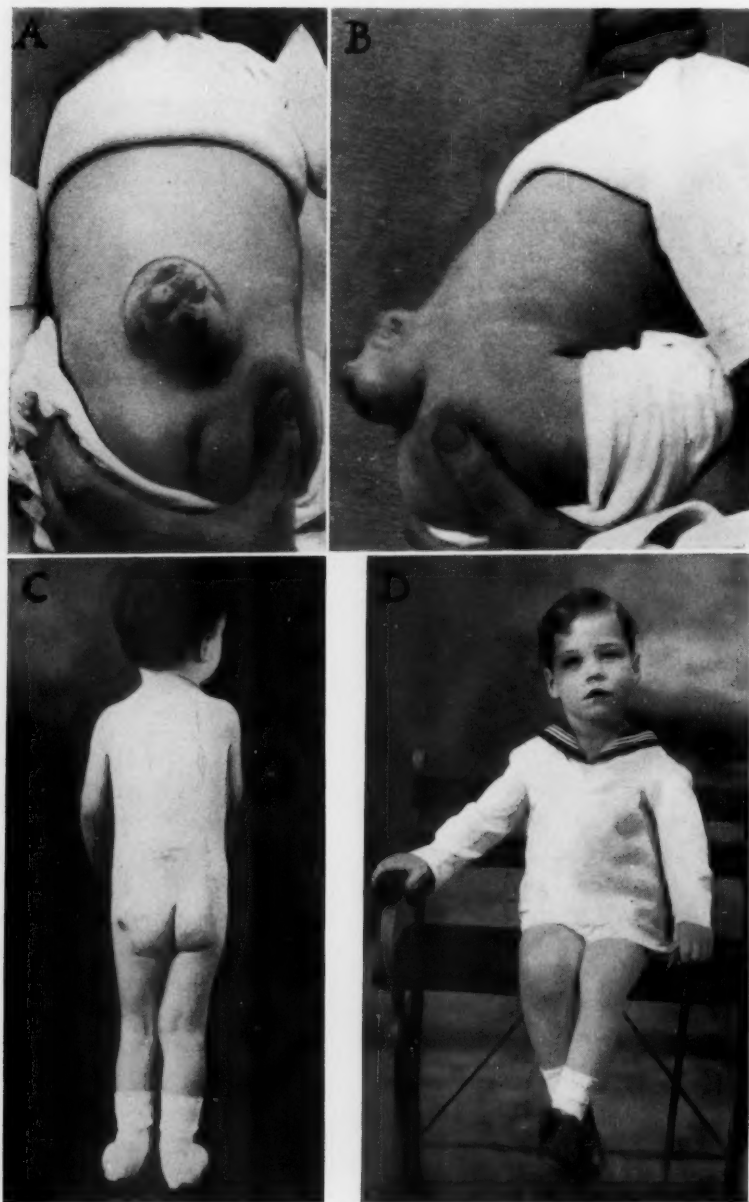


FIG. 1.—(Case I.) (A) Sacral myelomeningocele. Taken two days before the operation when the child was six months old, showing the extent of the protrusion and ulceration. (B) Lateral view of same protrusion. (C) Photograph taken eighteen months after the operation. There is no evident recurrence of the protrusion. (D) Child two years old. No evidence of hydrocephalus.

there was a slight but appreciable increase in the size of the skull. Thereafter no obvious expansion occurred and the child has been followed for eighteen months, is now two

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years old, mentally alert and has no apparent physical impairment other than some vesical incontinence which is becoming less.

CAUSES OF SPINA BIFIDA.—According to Frazier,¹ the one feature common to all varieties of spina bifida is the imperfection in the mesoblast. Many theories have been advanced as to the contributing factors in the cause of this anomaly: namely, (*a*) that these hernial protrusions from the vertebral column or cranium are primarily due to a defect in the bone; (*b*) that there is a derangement of the brain which causes an increase of the cerebrospinal fluid; (*c*) that there is an obstruction to the normal passage of cerebrospinal fluid, and (*d*) that the absorption of cerebrospinal fluid is incomplete, resulting in an hydrocephalus. There is yet no conclusive evidence to indicate which is the dominant factor, or indeed that there is a single dominant factor, as evidenced by the presence of hydrocephalus and the absence of fusion and ossification in utero of the mesoblastic plates containing the rudimentary laminae. The failure of the cranial bones and the vertebral arches to close may be the result of an incipient hydrocephalus in utero, the bony defect serving as a vent for the increased spinal fluid which must either expand the cranial bones and increase the bulging fontanelles or else find some other outlet for the ever-increasing fluid pressure at some weakened point in the cranium or spinal column. It is very probable that the size of the bony defect depends on how soon the internal pressure of the increased cerebrospinal fluid has become manifested in utero and finds a vulnerable place in the bony structure which has not yet fused and become ossified.

CLASSIFICATION OF SPINA BIFIDA.—In grouping the cases of spina bifida cystica we have followed the classification of Von Recklinghausen,² and to further simplify the tabulation we have divided them into three separate entities, namely, meningocele, myelomeningocele and syringomyelocele. (Tables I, II, III, and IV.)

TABLE I
Sex Incidence

	Male	Female
Occipital.....	9	5
Cervical.....	1	2
Dorsal.....	2	4
Lumbar.....	27	21
Sacral.....	7	6
	—	—
	46	38
Total.....	84	

TABLE II
Sex—Location

	Male	Female
Occipital.....	2 meningoceles	2 meningoceles
	7 myelomeningoceles	3 myelomeningoceles
Cervical.....	1 meningocele	2 meningoceles

TABLE II *Continued*

	Male	Female
Dorsal.....	1 meningocele 1 myelomeningocele	1 meningocele 2 myelomeningoceles 1 syringomyelocele
Lumbar.....	5 meningoceles 21 myelomeningoceles 1 syringomyelocele	5 meningoceles 15 myelomeningoceles 1 syringomyelocele
Sacral.....	1 meningocele 6 myelomeningoceles	6 myelomeningoceles
	— 46	— 38

No cases of spina bifida occulta were included in this series, although two such cases were recognized, one by a dimple and the other by a tuft of hair in the lumbar region. They were admitted to the hospital for acute surgical conditions, bearing no relation to the defect in the spine and they presented no neurological signs. The diagnosis was corroborated by visible vertebral defects on radiographical examination. Neither case presented evidence of impairment of vesical or rectal function.

Meningoceles.—The nineteen children with meningoceles presented the following findings. In eleven children the dural protrusions were covered with skin which appeared to be normal in texture. (Table V.) The skin covering the other eight of these meningoceles was under considerable tension so as to resemble a thin parchment membrane which not infrequently was transparent and simulated a myelomeningocele. The herniation varied in size from that of a small walnut to the size of the infant's head depending on the extent of the intraspinal and intracranial pressure. The extent of the skeletal defects ranged from that of a pinpoint opening in the incompletely fused laminae to the complete absence of one or more of the arches in the spine. The cranial defect was a circumscribed opening which in no case was larger than a quarter. The largest meningoceles were observed at the base of the occipital bone and the smallest in the dorsal region. Large dural protrusions in at least 30 per cent. of the cases received their cerebrospinal fluid through minute openings in the cranium or vertebral column. The diameter of the saculation bore no direct proportionate relation to the size of the defect in the bony framework.

Myelomeningoceles.—While fundamentally the nature of this disease was the same as that of meningoceles, it differed in that the bony defects were more extensive and presented disabilities and symptoms because of the presence of nerve filaments or brain substance in the dural sac. (Tables V and VI.) The following observations were made in the forty-two cases of myelomeningoceles. The skin covering the protrusion in twenty-three children was thinned out, translucent and cystic. The sac in three of these children had spontaneously ruptured at birth with the escape of cerebrospinal

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TABLE III

	Age on Admission											
	1 to 7 days	8 to 15 days	15 to 28 days	5 to 8 wks.	2 mos.	3 mos.	4 mos.	5 mos.	6 mos.	7 mos.	1 yr.	2 yrs.
Occipital.....	7	3	1		1	1	1					1*
Cervical.....		2			1	1			2	1		1
Dorsal.....	4	5	5	3	3	1	1		1	1		2
Lumbar.....	24	2	1	1				1			1	1
Sacral.....	4											

* Orbital.

TABLE IV

	Age Operated											
Occipital.....	4	2			1		1					1*
Cervical.....		2										
Dorsal.....	1		1		1					1		1
Lumbar.....	5	5	1	2	2				1		1	1
Sacral.....		1	1	1								

* Orbital.

TABLE V
Condition of Hernial Protrusions

		Firm Integument	Cystic	Ulcer- ated	Cerebro- spinal Fluid Exuding	In- fected
Cranial.	(4) Meningoceles operated.....	1 orbital	3			
	(5) Encephaloceles operated.....		5			
	(5) Encephaloceles inoperable....		1	3		
			1*	1*		1*
Cervical	(2) Meningoceles operated.....	2				
	(1) Meningoceles inoperable.....	1				
Dorsal..	(2) Meningoceles operated.....	1	1			
	(1) Meningomyelocele operated...		1*	1*		
	(2) Meningomyeloceles inoperable			2		
	(1) Syringomyelocele.....			1		
Lumbar	(8) Meningoceles operated.....	5	1			
			2*	2*		1*
	(2) Meningoceles inoperable.....	1		1*	1*	1*
	(9) Meningomyeloceles operated..		4	3	2	
	(27) Meningomyeloceles inoperable		3	21	3	
	(2) Syringomyeloceles inoperable.		1*	1*	1*	1*
Sacral..	(1) Meningocele operated.....	1	1			
	(5) Meningomyeloceles operated..	2	1*	1*		
			1*	1*	1*	
	(7) Meningomyeloceles inoperable	2	1			
			4*	4*		

* Indicates more than one complication of the integument in the same case.

TABLE VI
Associated Conditions Other Than Hydrocephalus

	Paraplegia	Talipes	Loss of Sphincters	Prolapse of Rectum
Cranial.....				
Cervical.....	1 meningocele*			
Dorsal.....	1 syringomyelocele		1 syringomyelocele	
Lumbar.....	12 myelomeningoceles* 2 syringomyeloceles	12 myelomeningoceles 2 syringomyeloceles	2 myelomeningoceles 2 syringomyeloceles	1 myelomeningocele 1 syringomyelocele
Sacral.....	2 myelomeningoceles	3 myelomeningoceles	1 myelomeningocele	1 myelomeningocele
	17	17	6	3

* One child had both a cervical meningocele and a lumbar myelomeningocele.

fluid resulting in a flabby saculation. In eight cases the sacs became ulcerated and in six cases a small sinus appeared simultaneously, from which cerebrospinal fluid exuded. This was generally followed by infection and an ascending meningitis. Occasionally with the escape of the cerebrospinal fluid the sac collapsed and the sinus walls coalesced and the perforation would close. With the decrease in the size of the sac the intracranial pressure was temporarily diminished, causing a recession of the bulging fontanelles. A period of readjustment of cerebrospinal fluid pressure would take place and the sac would not fill up to the dimensions observed before the perforation. In some patients the firm integument made the condition indistinguishable from meningoceles unless there was an obvious impairment in function of the nerve-roots. Nor did the presence of a few nerve-roots in the dural sac distinguish the subsequent course from that of a simple meningocele until months after the operation when the inability of the child to walk was discovered and vesical and rectal incontinence manifested themselves. Seventeen children were born with paralysis of their lower extremities. The presence of the spinal cord, nerve-roots or brain substance generally occurred through a broader bony defect and in these instances the summit of the fluid-filled protrusion was somewhat flattened and longer in the cephalic direction and appeared dimpled on its summit. This was not observed in the cases of encephaloceles. Hydrocephalus, congenital deformities of the extremities and bladder and rectal paralysis were more frequently observed in the children in whom the sacs had flattened surfaces than in the globular herniations. Ascending meningitis from ulcerating and leaking protrusions developed more readily in myelomeningoceles than in meningoceles. One child had a sacral myelomeningocele complicated by an evagination of the lower anterior abdominal wall and evisceration of the abdominal contents. We have been unable to find a record of a similar case in the literature.

Syringomyelocele.—The most disastrous group of cases were the syringomyeloceles. None of these patients were operated upon and all of them died within a month after admission. The defect in the vertebræ generally affected more than one lamina which was either absent or split. The defect included part or all of the spinal cord and nerve-roots giving the appearance of an excavation of the vertebral column. In two cases a large section of the vertebral column was entirely open without any coverings. These cases were complicated by deformities, hydrocephalus and sensory and motor disturbance with impairment of sphincter control. No case of cranioschisis was observed in this series.

Hydrocephalus.—The presence of hydrocephalus and the possibility of precipitating an acute hydrocephalus by the amputation of the sac was a dominant consideration in the treatment of all cases that might be amenable to surgery. (Table VII.) Hydrocephalus was present in nine of the thirty-seven children before they were operated upon, of which six were meningoceles and three were myelomeningoceles. Eight, of the thirty-two children in whom the sac was amputated, had hydrocephalus before their operation and it was increased in seven of these children after this procedure. Hydro-

TABLE VII
Hydrocephalus

	Hydrocephalus Present at Birth	Progressive Increase Developed after Amputation of Sac	Fol- lowed	Died	Amputation of Sac	Hydrocephalus Not Present before Oper- ation. Devel- oped after	Hydrocephalus Increased after Preservation of Sac	Deaths in Children with Hydrocephalus Who were Not Operated on
Cranial.....	1 M* oper.* 4 MM* no oper.*	yes for 3 yrs.	10 yrs.					4
Cervical.....	1 M oper. 1 MM no oper.	no	7 yrs.					1 wk.
Dorsal.....	1 SM* no oper.							2 wks.
Lumbar.....	1 M oper. 1 M oper. 1 M oper. 1 M oper. 1 MM oper. 1 MM no oper. 1 MM no oper. 1 MM no oper. 1 MM no oper. 1 MM no oper.	yes yes yes yes yes yes	2 mo. 1 yr.					3 mos. 4 wks. 5 wks. 4 mos. 7 mos.
				1 yr. 20 days 10 wks.				

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cephalus, which was not previously present, developed in four of the thirty-two children in whom the dural and arachnoid protrusion was amputated. Hydrocephalus which was present before operation was temporarily increased in one of the children in whom the sac was preserved and was not precipitated in the other four children in whom the membranes were not excised. The twenty-four children in whom there was no preëxisting hydrocephalus and who did not develop hydrocephalus after the operation while in the hospital were subsequently followed from two months to ten years without external evidence of increased intracranial pressure. The five myelomeningoceles in whom the sac was preserved and who were followed for five months to two and one-half years were operated upon by the method advocated by Penfield and Cone.³ They substantiated clinically their experimental observations that the amputation of the sac bore a direct relation to the absorption of spinal fluid and recommended the preservation of the dural sac. They agreed with Cutler,⁴ that hydrocephalus was either potential or existed with the hernial sac as a safety valve for the absorption of the increased cerebrospinal fluid.

ANALYSIS OF RESULTS

CRANIAL-BIFIDÆ.—There were fourteen children, or 16.8 per cent. with cranio-bifidæ. (Tables VIII and IX.) Four cases were meningoceles and

TABLE VIIIA

Total	Per-centage		Meningoceles			Myelomeningoceles			Syringomyeloceles
			Total	Oper-ated	No Op-eration	Total	Oper-ated	No Op-eration	
14	16.8	Cranial.....	4	4		10	5	5	
3	3.5	Cervical.....	2	2	1			1	
6	7.1	Dorsal.....	2	2		3	1	2	1
48	57.1	Lumbar.....	10	8	2	36	9	27	2
13	15.5	Sacral.....	1	1		12	5	7	
84			19	17	3	61	20	42	3

TABLE VIIIB

Meningoceles.....	20
Myelomeningoceles.....	61
Syringomyeloceles.....	3
	84

TABLE VIIIC

Operations		No Operation	
Meningoceles.....	17	Meningoceles.....	3
Myelomeningoceles.....	20	Myelomeningoceles.....	41
Syringomyeloceles.....	0	Syringomyeloceles.....	3
	37—44%		47—56%

Results.—25 of the 37—67.6 per cent survived. 12 of the 37—32.4 per cent died.

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TABLE IX

Follow-Up of Patients Operated Upon

	2	2½	3	5	7	10	12	15	18	22	2	2½	4	7	10
	mos.	mos.	mos.	mos.	mos.	mos.	mos.	mos.	mos.	mos.	yrs.	yrs.	yrs.	yrs.	yrs.
Cranial..			2				1								1
Cervical..							1							1	
Dorsal...				1		1		1							
Lumbar..	3	1	1				3	1	3			1			1
Sacral...					1					1	1		1		
	3	1	3	1	1	1	5	2	3	1	1	1	1	1	2

ten were encephalomeningoceles. Of the four meningoceles all of which were operated upon, three were posterior and one was situated in the orbital region. One infant who was four days old at the time the occipital meningocele was excised died two days later from meningitis without evidence of hydrocephalus. Of the other three children who were operated upon one was followed for ten years and two of the children returned for three months. The child who was followed for ten years (Case II) (Figs. 2A, 2B, 2C and 2D) presented in the occipital region a large fluctuant tumor the size of an orange with small vesicles in the skin at its base. The sac was thin, blue in color with bulging vessels which were particularly prominent when the child cried. An operation was performed when the infant was six days old at which time the dural sac containing only cerebrospinal fluid, was excised down to the defect in the skull which was about one inch in diameter. The wound healed by primary union. Soon thereafter a moderate hydrocephalus developed. This receded and recurred to an appreciable extent until the child was about three years old. Thereafter there was no increase in the size of the head which would be considered out of proportion to the growth of the child who has been seen at yearly intervals. His mentality is normal and there is no physical impairment. The third infant was three months old on admission and presented a papillomatous fluctuant occipital meningocele which was four inches in diameter. The sac was amputated. No hydrocephalus developed nor has there been any evidence of recurrence. The child with the orbital meningocele was three years old on admission. He presented a swelling over the bridge of the nose which was fluctuant and tense and was mistaken for a dermoid. At operation the pedicle led to the region of the inner canthus of the right orbit from which cerebrospinal fluid exuded. This fluid drained for seven days. There has been no recurrence during the three months that the child has been followed.

Five of the ten encephalomeningoceles were operated upon and five were considered as inoperable. Of the five children operated upon two died from shock. The other three infants died from meningitis, two, eleven and twenty days after surgical intervention. Considerable brain tissue was present in the sacs of all five children operated upon. In two patients the brain tissue was replaced, in two the protruding cerebellum was resected as it could not be replaced and in the fifth case the condition was found too extensive to

return into the cranium. Of the five children with encephalomeningoceles upon whom there was no surgical intervention, one had a tumor the size of a lemon with a tremendous hydrocephalus which rapidly increased in size. The child died within three months. The second infant presented a grape-

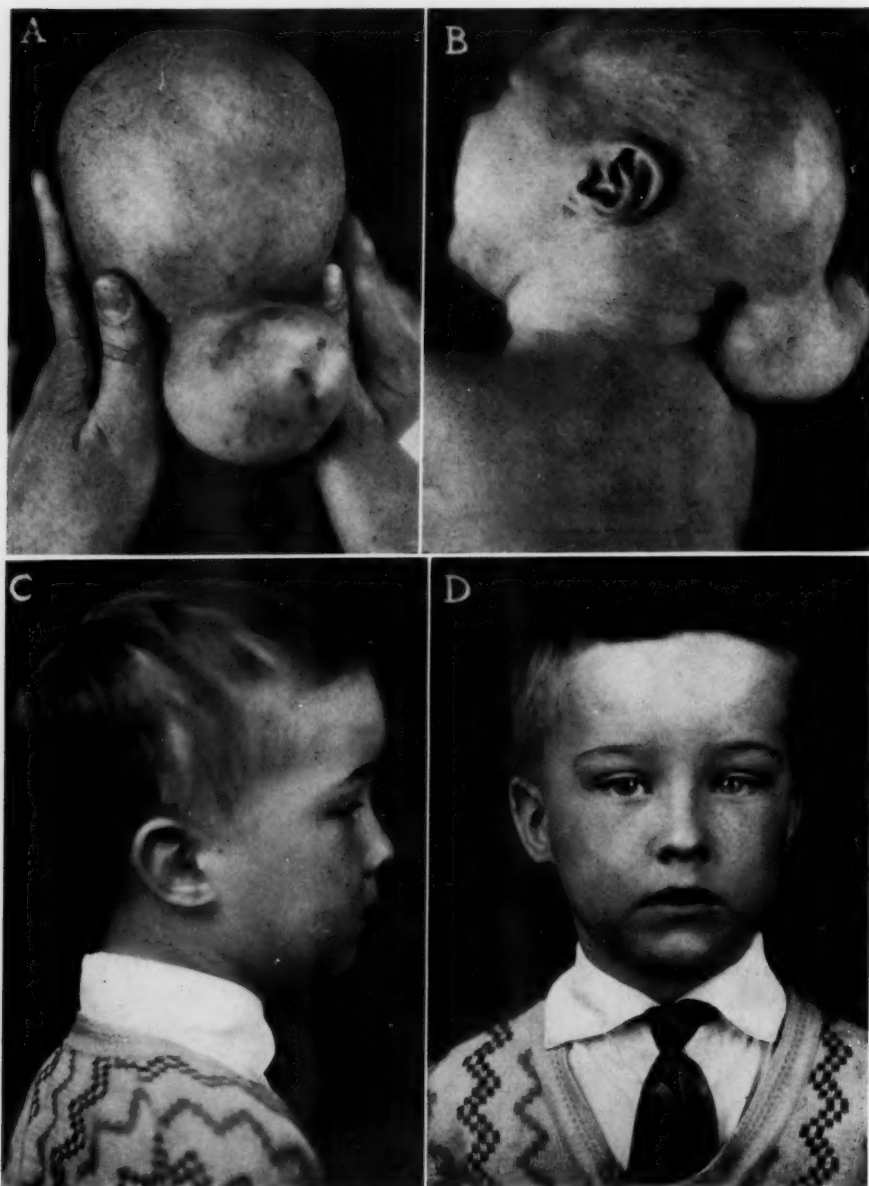


FIG. 2.—(Case II.) (A) Photograph of a case of occipital meningocele taken when the child was five days old. (B) Lateral view of the same case. Child operated upon when he was six days old. (C) Lateral view of the boy when he was six years old. There is no evidence of recurrence. (D) Anterior view taken at the age of six years. There is no evidence of hydrocephalus. The patient has been followed for ten years.

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fruit sized cerebellar herniation, which ulcerated and became infected, and the child died of meningitis. Two of the children succumbed from progressive hydrocephalus which became very pronounced and gave the children the appearance of monstrosities. In the fifth case there was a soft flabby encephalomeningocele which was ulcerated and complicated with hydrocephalus. This child died twenty-one days after birth from gastroenteritis and an ascending meningitis.

Cervical Spina Bifida.—The three cervical spina bifidæ which comprised 3.5 per cent. of all of the cases were children with meningoceles. One child was nine days old and also had a larger myelomeningocele in the lumbar region. The mass in the cervical region was the size of a small orange, soft, puffy and fluctuating while the larger sac over the fourth lumbar region was transparent, ulcerated and receded with inspiration. There was present a moderate degree of hydrocephalus. The child developed an ascending meningitis and died one week later. Of the two other meningoceles one patient was two weeks old on admission and presented a mass the size of a hen's egg which protruded through the fifth cervical vertebra. There was a moderate hydrocephalus and bulging of the fontanelles. The sac was amputated and the hydrocephalus did not increase after the operation. The child is now seven years old without any mental abnormalities. The other patient with a meningocele was eight years old, mentally deficient and afflicted with a spastic paraplegia. At operation no nerve filaments were found in the amputated sac which protruded through a defect in the fifth and sixth cervical vertebra. One week later the hernial protrusion recurred and became ulcerated. It eventually healed but was not re-operated upon. This patient was followed for a year without evidence of hydrocephalus.

Dorsal Spina Bifida.—There were six dorsal spina bifidæ, or 7.1 per cent. of the eighty-four cases. Of these, two were meningoceles, three myelomeningoceles, and one was a syringomyelocele. Three of these patients died without being operated upon. Two were children with myelomeningoceles, one child who was a week old on admission had an ulcerated leaking dura, and the other child who was one day old on admission lived six days with an infected ulcerated sac. Both of these infants developed meningitis. The third patient which died without surgical intervention had a syringomyelocele; she was two months old on entering the hospital with an ulcerated hernial protrusion which extended from the twelfth dorsal to the first lumbar vertebra, associated with hydrocephalus and complicated by meningitis. Of the three patients operated upon two had a meningocele and one a myelomeningocele. One of the children with a meningocele was three days old and presented a soft cystic pedunculated mass the size of an orange which involved the fifth and sixth dorsal vertebrae and presented no neurological symptoms. The sac was amputated two days after admission. The child was followed for fifteen months without developing hydrocephalus or any untoward symptoms. The other child with a meningocele was three months

old with the tumefaction the size of a walnut in whom the overlying skin was in good condition. The sac was amputated. No hydrocephalus developed. The child was followed for five months without any abnormalities developing. The third patient (Case III, Figs. 3A, 3B and 3C) had a myelomeningocele which was operated upon twenty-one days after birth. The sacculation was the size of an orange with a thin integument. It had ruptured before admission and exuded cerebrospinal fluid. The sac was exposed under a cradle to the heat of a carbon light. The wound closed and the protrusion increased moderately in size. No hydrocephalus developed. The child developed gastroenteritis. At operation the sac and nerve filaments were preserved. The wound became infected and was again exposed to a heating lamp. The gastroenteritis recurred. The wound subsequently healed and the child was well on discharge from the hospital. She has been followed for ten months without any untoward symptoms or evidence of hydrocephalus.

Lumbar Spina Bifida.—Patients with lumbar defects made up forty-eight cases, or 57.1 per cent. of the spina bifidæ. Of these ten were cases of meningoceles of which eight patients were operated upon and two were considered inoperable. There were thirty-six children with myelomeningoceles, of which nine were operated upon and twenty-seven were thought to be inoperable. Two patients with syringomyeloceles were not considered operable. Four of the lumbar myelomeningoceles involved the first sacral segment. The skin covering the dura of the two meningoceles which were inoperable, was normal in one of the children, while in the other it was ulcerated and cerebrospinal fluid exuded. In the latter case the patient died of meningitis from the ulcerated and infected sac, while the other child was followed for one year; the mother observing no symptoms refused to bring the child to the clinic. The condition of the sac in eight of the meningoceles which were operated upon was as follows: in five the integument was good, in three the skin was thin and cystic, two of which became ulcerated. Hydrocephalus was present before and increased after the amputation of the sacs in four of the eight children with meningoceles. One child was followed for two months at the end of which time cerebrospinal fluid was found to be exuding from the operative wound; the second child's head increased rapidly in size after surgical intervention and died on the twentieth day from erysipelas; the third child lived for a year with a progressively increasing hydrocephalus and died from bronchopneumonia complicating measles; the fourth child, in whom hydrocephalus progressed further after the excision of the protruding dura, was followed for one year at which time there were no untoward symptoms. The fifth child died on the seventh day of meningitis following amputation of the sac. The remaining three of the eight children who were operated upon by amputation of their meningoceles were followed for eighteen months with no evidence of hydrocephalus or other disturbances of the cerebrospinal system.

The condition of the sac in the thirty-six cases of lumbar myelomeningo-

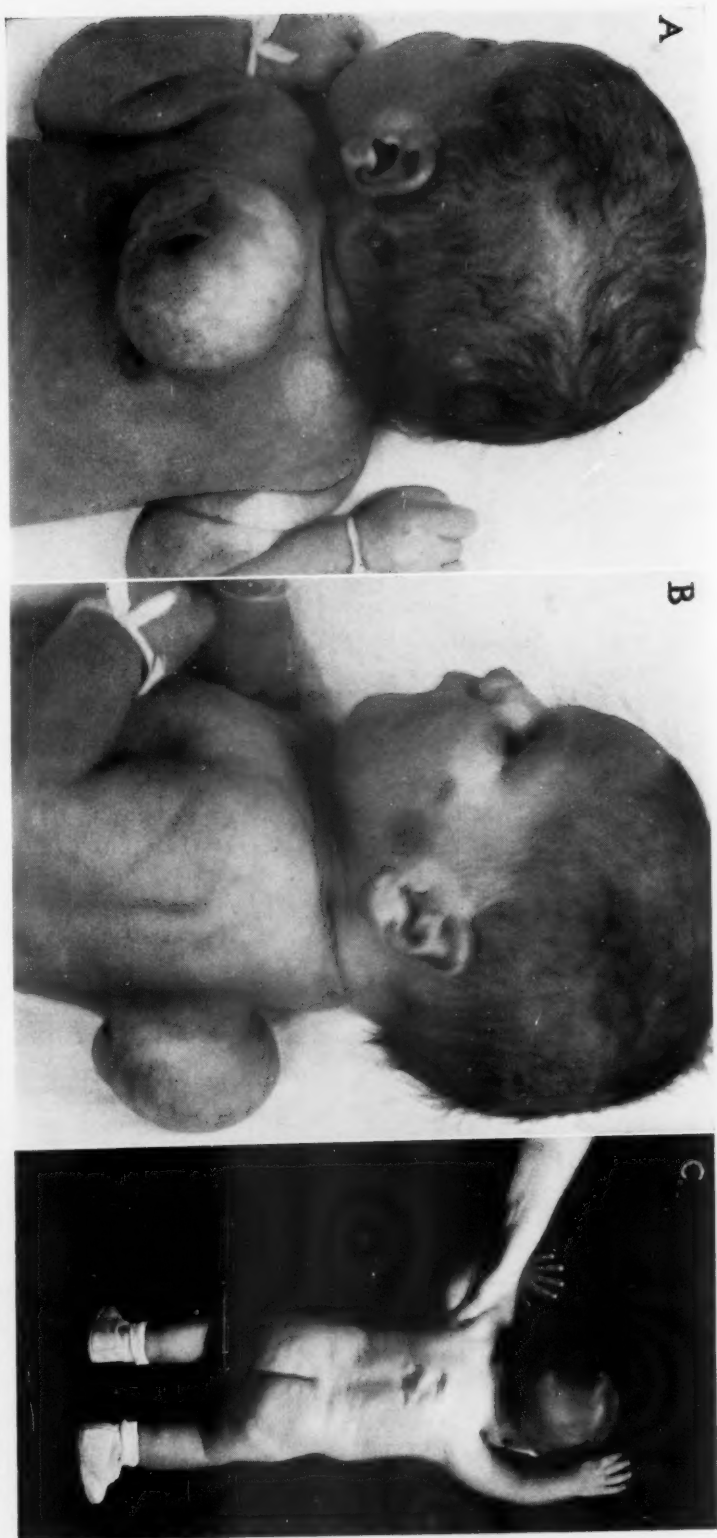


FIG. 3.—(Case III.) (A) Dorsal myelomeningocele. Photograph taken when child was twenty-one days old. Note perforation of dural sac. (B) Lateral view showing extent of the base of the tumor. (C) Photograph taken eleven months after operation showing extent of operative wound. There is no evidence of hydrocephalus.

celes was as follows: of the twenty-seven children who were not operated upon the herniation was ulcerated in twenty-one, cystic and flabby in three and cerebrospinal fluid exuded from three. The sac in the nine cases of myelomeningoceles in whom operation was performed presented an ulceration in three, a cystic and flabby appearance in four, and cerebrospinal fluid escaped in two. Hydrocephalus was present at birth in only one of the patients operated upon and in eleven who were not subjected to surgery. Hydrocephalus developed in only four of the nine patients in whom the sac was excised. Paralysis of one or more of the lower extremities was present in nine of the unoperated children, and in three of the children operated upon. Talipes equinus of one or both extremities was present in ten of the unoperated and two of the children operated upon. Marked prolapse of the rectum was present in one of the children operated upon and in one of the unoperated cases. One lumbar myelomeningocele was complicated by a cervical myelomeningocele and hydrocephalus previously referred to. Of the twenty-seven myelomeningoceles that were not operated upon, nineteen died from infection extending to the meninges, two from bronchopneumonia, and six from progressive hydrocephalus. Twenty-one children died within one month after birth, five within six months and one at the end of a year. Of the nine cases of myelomeningoceles that were operated upon, hydrocephalus followed the amputation of the sac in four; of these one lived for two months; another child with an associated bilateral equinus died within a month; the third lived two months with a flaccid paralysis of the extremities, and the fourth lived for twenty-nine months with paralysis of the left leg and partial paralysis of the right. One child died of meningitis and another of bronchopneumonia. Two children were followed for two months and one for eight years without any impairment other than a slight talipes equinus which was much improved with the application of a brace (Case IV, Figs. 4A, 4B, and 4C). The two children with lumbar syringomyeloceles were deemed inoperable. One was a boy three months old who was admitted with a large thin sac with a broad base. The summit was retracted and red. Radiographical examination revealed a defect of the lumbar arches and first sacral segments. The extremities were paralyzed and there was a prolapse of the rectum. Cerebrospinal fluid exuded from the wound which became ulcerated and infected and meningitis followed. The other case was a month old boy with a large cystic mass excavated and thin involving the lumbar and lower dorsal regions. There was a moderate hydrocephalus, an exudation of cerebrospinal fluid from the protrusion and a flaccid paralysis of the lower extremities. Operation was not undertaken and the child was taken to another hospital where he died a month later from a progressive hydrocephalus and meningitis.

Sacral Spina Bifida.—There were thirteen cases or 15.5 per cent. of sacral spina bifida of which one showed a meningocele and twelve myelomeningoceles. Seven children with myelomeningoceles were considered inoperable; all seven died within a period of seven months, three of whom died twenty-

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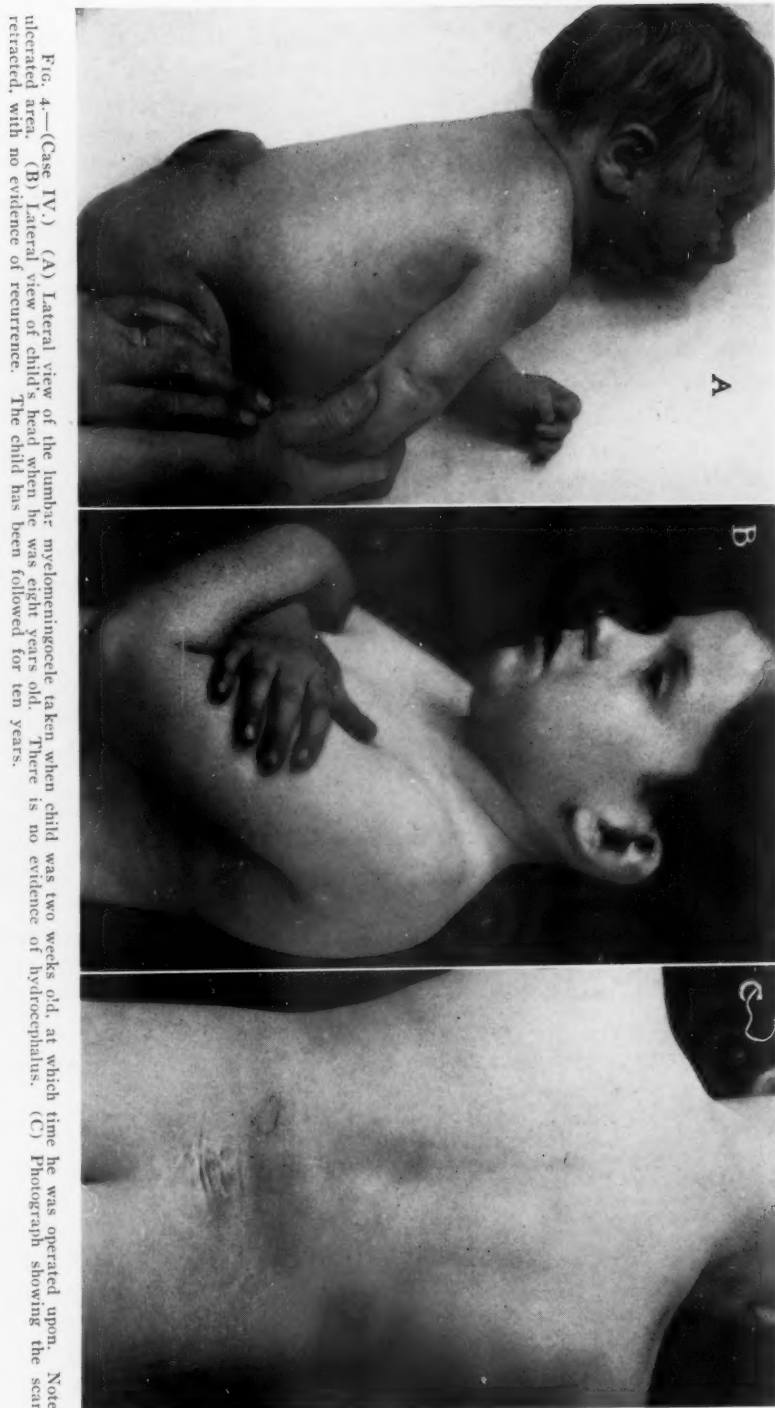


Fig. 4.—(Case IV.) (A) Lateral view of the lumbar myelomeningocele taken when child was two weeks old, at which time he was operated upon. Note ulcerated area. (B) Lateral view of child's head when he was eight years old. There is no evidence of hydrocephalus. (C) Photograph showing the scar retracted, with no evidence of recurrence. The child has been followed for ten years.

four hours after admission to the hospital. One of these children presented a mass over the left buttock which was four inches in diameter and was covered with normal skin. This condition was complicated by a large eventration of the anterior abdominal wall including all of the intestines. The thin transparent peritoneum overhung the genitalia and was further complicated by clubbing of the feet. The child died soon after birth. Three of the six inoperable children died from progressive hydrocephalus and the other three died from infection of the ulcerated hernial protrusion which resulted in meningitis. Of the six children that were operated upon five had myelomeningoceles and one had a simple meningocele. Two of the cases of myelomeningocele died; one child, who was twenty days old discharged cerebrospinal fluid from the sac which was red and ulcerated. The sac which was freed of its nerve filaments was amputated and the infant died of meningitis two days later. The other myelomeningocele which died was six weeks old on admission and presented an hydrocephalus with a soft cystic mass the size of an orange. At operation the nerve filaments were replaced and the sac was amputated. The child died twenty-one days later from a progressively increasing hydrocephalus. Death was inevitable although there was a remote possibility that the hydrocephalus would remain arrested after the operation. Of the three children with myelomeningoceles that survived their operation, in one the sac was amputated and in the other two the sacs were preserved. The sac was amputated in a child who was three years old on admission to the hospital at which time he presented a circumscribed swelling four inches in diameter over the sacral region extending over to the right and which was covered with thick skin. The tumor appeared lobulated and was of a doughy consistency simulating a lipoma. At operation the fine filaments of nerves were separated from the sac and replaced into the small defect in the bone. The sac was excised. After the operation there was a suppression of urine which necessitated frequent catheterization. Subsequently the patient continuously wet and soiled her linens with urine and faeces as she had done before the operation. She has been followed for four years. By diligent training the patient will avoid soiling her clothes if she is reminded to urinate every two or three hours. She is unable to sleep through the night without wetting her bed. The patient is very constipated, several days will pass without defecation unless she is given an enema. She occasionally experiences a fullness in her lower abdomen due to pressure of the faeces of many days accumulation. She manages very well at school and participates in all activities.

Of the two patients with sacral myelomeningoceles in whom the sacs were preserved, one (Case I) referred to previously, is now two years old. The other child (Case V), (Figs. 5A, 5B, 5C and 5D) was operated upon when he was two weeks old. The skin over the protruding sac was firm in texture and extended from the posterior superior spine to the coccyx. The tumor was cystic and fluctuant. There was no evidence of any other complication. At the operation the sac and nerve filaments were preserved

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and a fascial covering was approximated over the folded sac. The wound healed by primary union. No evidence of hydrocephalus was present before or after the operation. The boy has been followed for twenty-two months, is alert but continually soiling himself with urine in spite of efforts at regulation. He is inclined to be constipated. There is no paralysis or deformity of the extremities. The sixth case that survived the operation was a meningocele. This child was two and one-half years old when he was admitted to the hospital. He presented a soft fluctuant mass over the right sacro-iliac region the size of half of a lemon with a finger like projection of skin one and a half inches long. No nerve filaments were found at operation and the sac was excised and the defect in the bone covered by a fascial layer. The wound healed without the development of hydrocephalus. The child although she developed diphtheria in the hospital, survived and has been followed for seven months without any apparent disability or hydrocephalus.

Mortality.—The high mortality following the operation for this congenital anomaly can be attributed to the selection of cases which it is reasonable to suppose were doomed if not subjected to surgery (Tables X and XI). Not infrequently infants without any other disease seemed suitable for operation but died a few days after admission from some intercurrent disease or from

TABLE X
Cause of Death of Operated Cases

	Meningitis	Bronchopneumonia	Hydrocephalus	Shock
Cranial.....	1 meningocele 2 myelomeningoceles 1 myelomeningocele*		1 myelomeningocele* 2 myelomeningoceles	
Cervical.....				
Dorsal.....				
Lumbar.....	1 meningocele	1 myelomeningocele	1 meningocele**	
Sacral.....	1 myelomeningocele 1 myelomeningocele*		1 myelomeningocele*	

** Erysipelas.

one of the many complications commonly associated with this condition. Some clinics have recorded a larger percentage of children that were operated upon with a smaller mortality. But it seemed to us that the forty-nine patients who died without operation would not have survived had they been subjected to surgery. An analysis of these cases revealed some complication

TABLE XI
Cause of Death of Cases Not Operated Upon

	Meningitis	Gastroenteritis	Bronchopneumonia	Hydrocephalus
Cranial.....	1 myelomeningocele	1 myelomeningocele*	1 myelomeningocele*	3 myelomeningoceles 1 myelomeningocele*
Cervical.....	1 myelomeningocele*			1 myelomeningocele* also lumbar myelomeningocele which ulcerated

TABLE XI *Continued*

	Meningitis	Gastroenteritis	Bronchopneumonia	Hydrocephalus
Dorsal.....	1 myelomeningocele 1 myelomeningocele* 1 myelomeningocele*		1 myelomeningocele*	1 myelomeningocele*
Lumbar.....	1 meningocele 15 myelomeningoceles 3 myelomeningoceles* 1 myelomeningocele*	1 myelomeningocele*	2 myelomeningoceles 1 myelomeningocele*	6 myelomeningoceles 3 myelomeningoceles* 1 myelomeningocele*
Sacral.....	2 myelomeningoceles 2 myelomeningoceles ^b		1 myelomeningocele	1 myelomeningocele 2 myelomeningoceles*

* Indicates the complications present in the same case at death.

to account for their early death which showed the futility of operation. The ultimate decision of whether or not to operate was generally the consensus of opinion of the visiting staff. The results that have been tabulated show that 67.7 per cent. of the thirty-seven patients that were operated upon survived and have been followed from two months to ten years; that the immediate operative mortality was 32.3 per cent. and that only 44 per cent. of the eighty-four cases that were admitted to the hospital were operable.

INDICATIONS AND CONTRA-INDICATIONS AND TIME TO OPERATE

Children with meningoceles presented the largest percentage of cases that were benefited by surgical intervention. If the dural protrusion was covered with normal skin and there was no evidence of hydrocephalus, the most favorable time to operate was as soon after birth as the general condition permitted.

In the absence of hydrocephalus and the presence of a sac that is thin and translucent, operation is advised before the sac perforates, ulcerates or becomes infected, thereby eliminating a potential infection and minimizing the chances of an ascending meningitis. It is generally assumed that amputation of the sac will precipitate an hydrocephalus. The likelihood of hydrocephalus developing after operation should not preclude surgery as hydrocephalus does not always follow surgical intervention. If the skin covering the sac is ulcerated, an attempt to dry the secretion should be made with a baking cradle. The protrusion should be protected from excoriation from pressure by placing the infant on its side with a pillow under its hip and bandaging the uppermost ankle to the side of the crib in the direction it faces, or by encircling the protrusion with a large cotton doughnut. Operation is contra-indicated if the skin is persistently ulcerated and infected, and in the presence of a progressive hydrocephalus and bulging dural sac.

The conditions governing operation for myelomeningocele are the same as for meningocele except for consideration of the various complications. The presence of slight congenital deformities of the extremities which are amenable to treatment should not be a deterring factor in children otherwise suitable for operation. Talipes equinus of one or both legs should not preclude operation as this condition is responsive to plastic tendon correction or the use of appliances. The presence of a paraplegia does not justify

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operative interference, although Kolodny,⁵ advocated operation in their presence and reports favorably on the results. We have not been so fortunate. A girl ten years old, operated upon in another hospital soon after birth for a lumbar myelomeningocele with paraplegia, was admitted to the service in

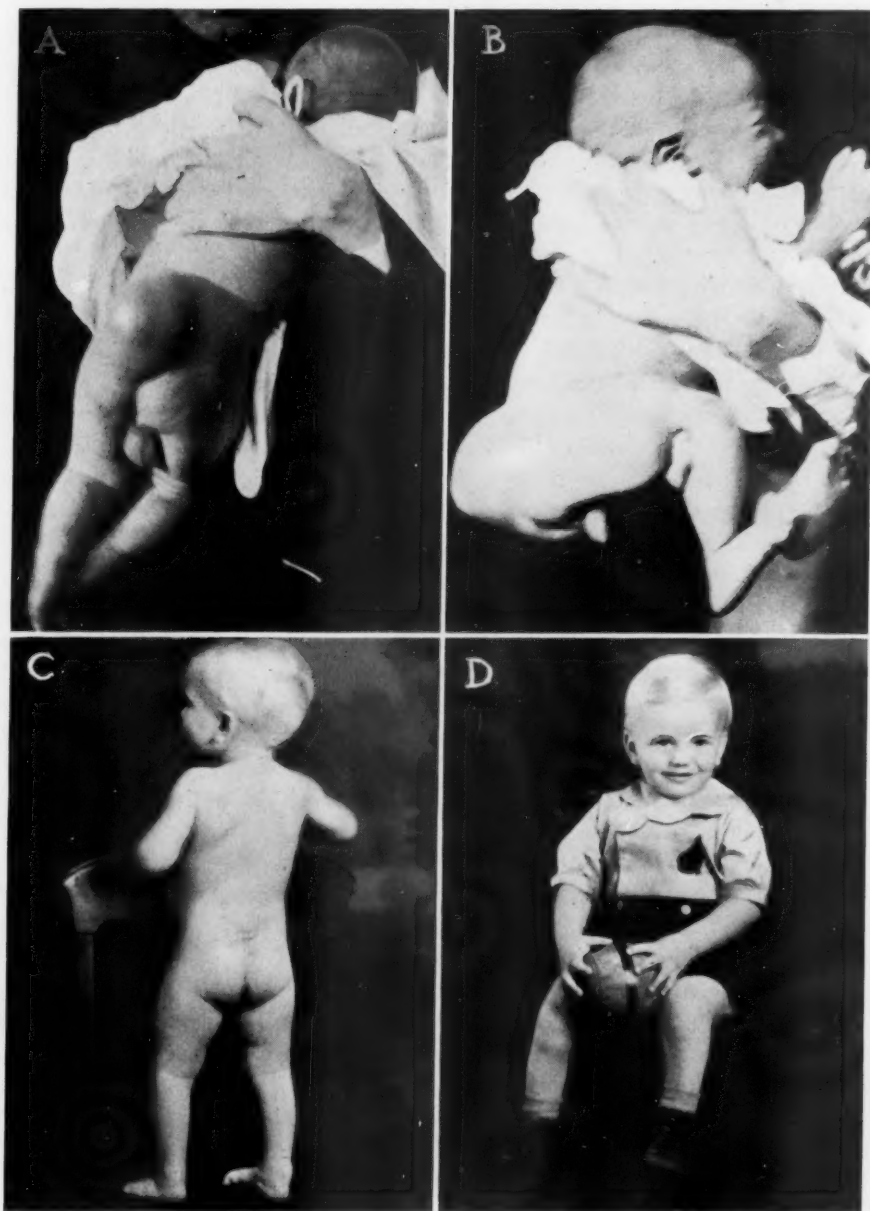


FIG. 5.—(Case V.) (A) Sacral myelomeningocele. Photograph taken when child was two weeks old, at which time he was operated upon. (B) Lateral view of the herniation. (C) Photograph taken twenty-two months after the operation, the sac is retracted. (D) Photograph showing the normal appearance of the head twenty-two months after the operation.

1933 with a fractured femur. She was mentally normal but suffered from bladder and rectal incontinence. The miserable existence since birth did not justify the prolongation of her life by operative intervention, as surgery did not improve her paralysis. The decision to operate on this type of case should rest entirely with the parents.

In no case did we effect a cure of vesical or rectal incontinence, but it was apparent that cases in which the sac was preserved were more readily responsive to training. The extent of vesical and rectal incontinence is difficult to determine in an infant. It becomes more manifest as the child grows older. Particularly is this to be observed in lumbar and sacral tumefactions. Constipation is more frequently observed than continuous expulsion of feces. If their faculties are not impaired they may cry or experience pain when the rectum is impacted.

The presence of a progressive hydrocephalus with a large or small myelomeningocele is a contra-indication to surgery. Removal of the dural sac and the repair of the defect will invariably be followed by an increase in the size of the existing hydrocephalus with an escape of cerebrospinal fluid or recurrence of the hernial protrusion. In one child the hydrocephalus increased after the operation and was followed by a recurrence of the hernial protrusion. Another operation resulted in recurrence and death. Occasionally hydrocephalus will not increase or else it will increase slowly and proportionately with the physical development of the child and then become arrested as equilibrium is established in the secretion and the absorption of cerebrospinal fluid. How great a compensatory factor the dura plays in each case cannot be determined until after attempting surgical correction. Our own observations in preserving the dural sac confirmed the conclusions of Penfield and Cone.³

In syringomyelocele surgery is not indicated. The extensive defect of the bony structure with eventration of cord and associated paralysis, deformities and advanced hydrocephalus are too much to relieve by surgical intervention.

Preoperative Treatment.—An infant who is amenable to surgery should continue on breast feedings. So many children die within the first month of life that general supportive measures should be exercised. The child should be kept on its side or on its abdomen and the tumefaction properly protected from pressure with a large cotton doughnut to prevent abrasions, ulceration and leakage of cerebrospinal fluid. Deferring operation will often prove fatal in selective cases which are suitable for repair. Gastro-intestinal disturbance has played an important rôle in undermining resistance and has often failed to respond to treatment. If the operation is deferred because of the condition of the skin covering the sacculation it should not be delayed too long beyond the period when the infant has regained the weight it lost since birth. The use of a baking tent will be found beneficial to dry the ulcerated skin, close a leaking sinus and help to maintain the body heat.

Treatment.—Aspiration of the fluid contents is strongly contra-indicated

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as infection is very prone to develop. The injection of sclerosing solution is strongly to be condemned. It is generally assumed that surgery in selective cases is the only method that offers any hope of correction of this congenital anomaly.

The amputation of the sac as it emerges from the spinal or cranial defect has for many years been the accepted procedure. (Table XII.) Some

TABLE XII

	Sac Amputated	Sac Preserved
Cranial.....	4 meningoceles 5 myelomeningoceles	
Cervical.....	2 meningoceles	
Dorsal.....	2 meningoceles	1 myelomeningocele
Lumbar.....	8 meningoceles 8 myelomeningoceles	1 myelomeningocele
Sacral.....	1 meningocele 2 myelomeningoceles	3 myelomeningoceles

surgeons have endeavored to dissect the nerve filaments from the dura and arachnoid and replace them and the brain contents into the bony defects. Penfield and Cone³ advocated the preservation of the sac to prevent the precipitation of acute hydrocephalus. They concluded from various experiments, "that the sac was an absorbing mechanism that cerebrospinal fluid might find its way out of the confines of the arachnoid through the protrusion, that hydrocephalus may be precipitated by the amputation of the protrusion and that plastic operation with the preservation of the sac is not complicated by such a sequel." In twenty-four of our thirty-seven children hydrocephalus was not in evidence before or after their operations. Hydrocephalus was not precipitated in four of the children with myelomeningoceles in whom the sac was preserved and there was a progressive increase in the size of the head for only about two months in a fifth case of myelomeningocele in whom the sac was not amputated. Inasmuch as acute hydrocephalus was not actually precipitated in any of the children in whom the sac was preserved this procedure should therefore be universally accepted. The preservation of the dura and arachnoid leaves a fullness over the bone defect which persists for a few months but gradually becomes less perceptible.

Preliminary Preparation.—The child should not be unnecessarily exposed on the operating table. The blankets should be warm and the child while lying on its abdomen should be placed in the Trendelenburg posture for closure of spinal defects and prone for cranial repair. This will minimize the unnecessary loss of cerebrospinal fluid. The extremities should be wrapped in cotton and held to the table with bandages. Picric acid solution in alcohol is used for sterilization of the skin and as few drapes as are compatible with safety are used to cover the patient.

The use of $\frac{1}{2}$ of 1 per cent. novocaine as a local anaesthetic is preferable to general anaesthesia. It allows the surgeon to make the necessary infiltration with a perfectly adequate margin of safety. It minimizes the likelihood of respiratory complications and has effectively served our purpose in most of the cases that have survived. Stronger solutions are warned against as infants may be subject to idiosyncrasies. This occurred in one case in which the operation had to be suspended to resuscitate an infant as a result of using a 1 per cent. solution.

Operation.—Longitudinal elliptical incisions are utilized through the healthy skin which is then undermined to the base of the sac. As much skin as the condition will permit is preserved to facilitate the closure. If the skin is ulcerated nothing is to be gained by protecting the ulcer with gauze as it only impedes the operation. Instruments should not be used for healthy structures if once brought in contact with questionable tissue. The skin is reflected and the neck of the sac is exposed. All adventitious tissue is excised or reflected so as to have a clear view of the projecting sac to determine its extent as it emerges from the bony defect. The sac, if not inadvertently opened, is incised at its uppermost portion using caution not to sever any nerve fibres. The cephalic end of the dura is least vascular and is most apt to be devoid of nerve filaments. The fluid contents of the sac are allowed to escape slowly. An attempt is made to replace the sac into the vertebral or cranial openings. If this procedure is not feasible the sac is then bundled over the defect and held with fine interrupted chromic sutures. The fascia on both sides of the defect is incised as far lateral from its bony attachment as will permit the fascia of one side to be reflected over the folded sac and be sutured to the base of the reflected fascia of the opposite side of the defect. The fascia of the opposite side is then made to overlap the first reflected fascial covering and is sutured to the attachment of the pedicle of the first reflected fascial layer. If the folded sac is bulky this may not be readily accomplished and the severed ends of the reflected fascial layers should then be approximated without imbrication. No bony or fascial transplant was attempted nor did it seem indicated. If the overlapping or approximating of the fascial layers would be insufficient to withstand the increased pressure of fluid that might be precipitated as a result of the operation, certainly the transplantation of a bone or the fascial graft would not withstand the increased fluid pressure, nor had we the assurance that such grafts would not slough in infants. The skin edges were approximated with fine silk. A piece of cotton covered with collodion was found adequate as a dressing.

Post-Operative Treatment.—The patient is returned to its crib and held in a prone position on its side by placing a small pillow under one hip and bandaging the uppermost ankle to the side of the crib. This position is maintained for several days. "Less sudden change in intracranial tension interferes with brain metabolism." (Von Bergmann.⁶) Body heat is maintained with a lamp from a baking cradle which is covered with a blanket allowing the head to be exposed. The position of the child should not be

changed any more than necessary. The fontanelles and the region of the operation is watched for signs of increased intracranial pressure. Should the wound become infected the dressings should be removed and the operative area should be left exposed to an electric light to aid in drying the wound. With the healing of the incision the head can gradually be elevated. We have not varied the normal requirements of fluid intake in infants for the majority are operated on so soon after birth. Proper nutrition is a valuable adjunct in their management since gastro-intestinal disturbances are not infrequently present. It is therefore desirable that the infant be fed on mother's milk if possible.

Complications.—The loss of an excessive amount of cerebrospinal fluid or blood at operation may prove fatal. Added to the trauma of the operation the shock resulting from these factors are contributing factors in the immediate cause of death.

Infection of the wound with the development of ascending infection and meningitis was responsible for the loss of seven children. The development of acute hydrocephalus was the contributing cause of death in three cases. Gastro-intestinal infection and marasmus played no small factor in undermining the resistance of two children.

Rectal and bladder incontinence proved troublesome in the subsequent management of cases of myelomeningoceles particularly in the lumbar and sacral spina bifida in which there had been a prolapse of the nerve elements. The rectal sphincter paralysis frequently manifested itself by extreme constipation and a feeling of fullness which in the very young would be indicated by weeping. As the child grew older constipation would become more obstinate and would require frequent enemas and strong laxatives. This disturbance was less embarrassing than the vesical incontinence which gave the child no warning. Older children by training to void every two or three hours would in some cases prevent wetting themselves. The Coffey procedure for transplantation of the ureters has been suggested for relief in persistent cases in older children, to whom no sensation with habit formation can be developed. Delbet and Leri,⁷ and Dalziel,⁸ and Leopold,⁹ reported surgical cures of urinary incontinence in cases of spina bifida occulta. We have been unable to find a case of myelomeningocele in which incontinence has been cured by operation.

Operation has not benefited children with paralysis of extremities in any of our cases and rarely has operation benefited any case reported in the literature except those reported by Kolodny.⁵ Recurrence of the hernial protrusion took place in two children due to increased cerebrospinal fluid pressure and advancing hydrocephalus. A slight bulge may be perceptible and palpable over the operative area which will require no treatment. This becomes less appreciable with advancing years, particularly so in sacral meningoceles.

Parents should be warned against careless exposure to heat, particularly hot-water bottles. A child, who was operated on for a sacral meningo-

cele at the age of four years, burned her buttock below the operative incision when she was seven years old. It required many months of care before the area responded to treatment.

SUMMARY AND CONCLUSIONS

An analysis is recorded of eighty-four cases of spina bifida; forty-seven (56 per cent.) were not operated upon while thirty-seven (44 per cent.) were subjected to operation. Of those not operated upon all but one had died within twenty-four hours to one year after admission to the hospital. Of the thirty-seven patients operated upon there was a hospital mortality of 32.3 per cent. and the 67.7 per cent. which survived the operation have been followed for periods from two months to ten years.

In determining the cases that are suitable for surgical intervention and upon which successful results are dependent it is of the utmost importance to consider the following: First, the condition of the coverings of the protrusion. Second, the contents of the dura and the extent of involvement of the nerve, cord and brain tissue if present. Third, the extent of the defect in the bony structure. Fourth, the degree of hydrocephalus and other congenital deformities and anomalies.

The prognosis in infants who are suitable for operation is best when the operation is performed as soon after birth as the general condition permits, before unavoidable pressure produces ulceration and impending rupture, with leakage of cerebrospinal fluid and ascending meningitis, marasmus or some intercurrent disease to which they are susceptible.

The possibility that hydrocephalus may follow operative correction of a spina bifida should not cause one to defer intervention in a suitable case. Of the thirty-two children whose sacs were amputated, hydrocephalus increased in seven of the eight children in whom it was previously present and it was precipitated in but four of the children in whom there was no previous evidence of hydrocephalus. Hydrocephalus was not increased in a child in whom the sac was preserved nor was it precipitated in four other children in whom the dura and arachnoid were retained. The preservation of the dural sac as advocated by Penfield and Cone³ is recommended as the operative procedure of choice.

The presence of a spinal or occipital herniation which is thin, tense and then ruptures and alternately closes and ulcerates with a discharge of cerebrospinal fluid, complicated by a slowly progressive hydrocephalus, does not in all cases contra-indicate surgical intervention as the results of some of the operations are very gratifying.

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BRIEF COMMUNICATIONS AND CASE REPORTS

CARCINOMA OF THE RIGHT LUNG*

PNEUMECTOMY IN ONE STAGE

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CASE REPORT

Mrs. C., aged 61, was referred by Dr. R. Conklin to the Medical Clinic of St. Luke's Hospital, service of Dr. L. Frissell, with the following history: Eight years previously a Wertheim radical hysterectomy for epithelioma of the cervix had been performed by the author. Until one year before admission she remained entirely well, then she caught a cold which, though mild, persisted for weeks. A roentgenogram of the chest showed a typical bronchogenetic carcinoma of the right upper lobe. Subsequent roentgenograms showed a considerable enlargement and extension of the lesion (Fig. I.).

One week before entering the clinic she was seized with a sharp pain in the upper portion of the right chest, accompanied by a dry, hacking cough. The cough was relieved but the pain persisted and gradually spread to the back and to the right shoulder, accompanied by loss of weight and strength. Bronchoscopic examination by Doctor Hart revealed no pathology.

A diagnosis of primary carcinoma of the right lung was made. An artificial pneumothorax was induced and maintained until a satisfactory collapse with stabilization was obtained. A few days before operation, 450 cc. of air were introduced, the initial pressure being $-8 -0$, the final pressure $-2 +4$.

Operation.—February 20, 1935. One stage pneumectomy for primary carcinoma of the right lung. Time: Two hours.

Operator: Doctor Lyle. Assistant: Doctor Ada.

Pathologic Findings.—On opening the parietal pleura in the third right intercostal space, the lung was found to be adherent to the anterior chest wall. Further exploration showed that practically the upper half of the right lung was adherent to the parietal pleura down to the level of the fourth interspace. There was a rounded, stony hard, grayish tumor occupying the upper half of the right lobe. It had apparently invaded the parietal pleura and the endothoracic fascia attached to the third rib anteriorly. The attachment of the tumor to the parietal pleura would cover an area the size of a 50 cent piece. The apex was firmly adherent but the lower half of the lung was entirely free and collapsed, the thoracic space being occupied by air from the previous artificial pneumothorax. The lymph nodes at the hilus of the lung were enlarged and hard. There was no evidence of extension into the mediastinum. During the ligation of the vessel of the hilus of the lung, an encysted area of yellowish pleural exudate was encountered in the vertebral gutter.

Operative Procedure.—Anesthesia: Colonic oil-ether, plus positive pressure with nitrous oxide gas. Position: The patient was placed on the left side, the right arm raised above the head and the body elevated to an angle of 45 degrees. Rienhoff's anterolateral incision was made in the third right intercostal space. The incision extended from the

* Presented before the New York Surgical Society, April 24, 1935.

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border of the sternum to the midaxillary line and was deepened through skin, breast, pectoral and costal muscles until the bulging pleura was exposed. The thoracic cavity was then entered just below the lower portion of the tumor and in the area of the adherent pleura. The outlying fine adhesions were readily freed. As the tumor proved to be adherent to the overlying structures, it was decided to excise the third rib. The third costal cartilage was divided at its sternal extremity and the third rib, along with the second intercostal muscles and underlying pleura, was removed. The pleura over the dome of the right thorax was stripped off posteriorly to the level of the third rib and removed. A Lilienthal rib retractor was inserted and an excellent exposure of the root of the right lung was obtained.

The lung was separated from the mediastinum over an area of three inches, and

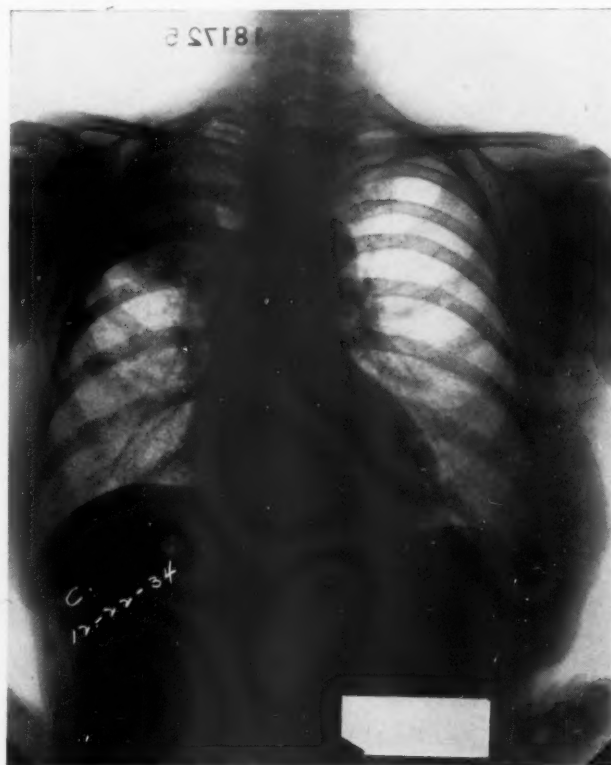


FIG. 1.—Roentgenogram taken December 12, 1934, showing the lesion in the right upper lobe.

two large pulmonary veins entering the hilus of the right lung were exposed, isolated and divided between silk ligatures. The pulmonary artery which lay in front and below the right primary bronchus was exposed, isolated and divided between silk ligatures. A thorough exposure was made of the right primary bronchus with its eparterial and hyparterial branches. A No. 5 braided silk suture was passed around the right primary bronchus and tied, completely closing the bronchus. A heavy clamp was applied to the main bronchus at the division into its two branches and the main bronchus severed between the clamp and the central ligature. This freed the hilus of the lung. The lung was then retracted medially and the parietal pleura divided at its reflection from the posterior thoracic wall. In this way an excellent exposure of the pulmonary ligament was obtained. The ligament was grasped between the fingers and divided. In its

division an unrecognized pulmonary vein was cut. It was promptly clamped with a loss of a very small amount of blood. The lung with peribronchial nodes was removed from the thorax. The cut end of the right bronchus was reinforced with interrupted silk mattress sutures. The incision in the thorax was closed in layers by interrupted mattress sutures with the object of making an air tight closure. This was difficult on account of the excision of the third rib, pleura, and intercostal muscles.

The patient stood the operation exceedingly well. There was no evidence of shock. Throughout the operation there was practically no loss of blood. At its conclusion



FIG. 2.—Photograph of the right lung showing the carcinoma in the upper lobe.

the patient was given a transfusion of 500 cc. of whole blood and was returned to the ward in good condition.

Pathological Report by Dr. L. C. Knox: Diagnosis: Carcinoma of lung, right upper lobe. Peribronchial nodes involved.

Macroscopic Examination.—Specimen consists of entire right lung, measuring 22 by 14 by 1 to 5 cm. Occupying the upper lobe is a very firm, friable, irregularly rounded tumor mass 6.5 by 4 by 7 cm. in diameter, situated 0.5 cm. from the medial surface and 0.5 to 1 cm. from the posterior surface of the lobe (Fig. 2). Anteriorly the tumor has been adherent to the thoracic wall and the overlying rib. The pleura in this region is thickened, adherent and infiltrated. On section the growth has a whitish yellow cellular cut surface which is mottled with anthracotic pigment and gives evidence of some necrotic change. The middle lobe is poorly delimited; however, in its upper

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anterolateral portion bordering on the anterior extremity of the transverse fissure is a small, superficial metastatic nodule measuring 1 by 1 by 0.5 cm. No other such nodules are found on section of the rest of the lung tissue which exhibits a uniform loss of aeration with a prominent bronchial tree. The remaining visceral pleural surface shows several scattered thin fibrous adhesions, most marked anteriorly. A portion of the rib included with the specimen reveals infiltration of the parietal pleura with tumor growth. The growth has been adherent to the chest wall in this region. A separate discrete nodule of tumor is attached close to the adherent area underlying the rib and measures 1.5 by 0.5 by 1 cm. Grossly it is difficult to determine how deeply the growth invades the thoracic wall. The hilar nodes are firm and appear infiltrated macroscopically.

Microscopic Examination.—Sections of the tumor from the margins of the mass show the center of it to be almost entirely necrotic, but at the periphery there is a zone of cellular tissue composed of large epithelial cells replacing almost all the normal struc-



FIG. 3.—Roentgenogram taken 12 days after operation, showing the right thoracic space filling with serosanguineous fluid.

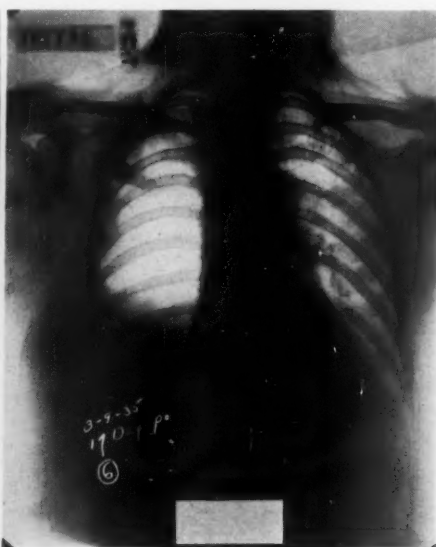


FIG. 4.—Roentgenogram taken 17 days after operation.

ture, filling the acini, and obliterating the architecture of the lung. These cells are extremely large, but very irregular. There are many degenerative changes with clear cytoplasm as well as very granular cells, possibly fatty. There are, however, many mitotic figures throughout. There is slight differentiation and a little palisading, although no intercellular bridges which can be certainly identified. The tumor, however, has the appearance of having arisen from the squamous epithelium and is of the morphologic group which forms the largest number of pulmonary tumors. It is impossible to state that morphologically it does not resemble an epithelioma from the cervix, but since such tumors metastasize very rarely and since this type is most commonly found in the lung, it would appear that the growth is primary in that region.

The nodes from the hilus of the lung adjacent to the bronchi show extensive fibrosis, necrosis, large masses of anthracotic pigment, and besides this an infiltration with tumor cells. Many of these are enclosed within dense fibrotic capsules. These nodes are adjacent to the cartilage of the lung, but neither the cartilage nor the mucous membrane is involved in the section. The morphology of the tumor is similar through-

out the sections. The growth extends nearly to the bone, which, however, is not involved in these sections.

Postoperative Course.—The first day after operation, the patient complained of dysphagia and severe pain in the right diaphragm. Respiration 28, pulse 100, temperature 99.3°, blood pressure 118/76. The left lung was well aerated and no râles were heard. The heart was slightly displaced to the left, but there was no cyanosis at any time. As a precautionary measure, the patient was placed in an oxygen tent for two days.

Roentgenograms taken the latter part of the first week showed a gradual accumulation of fluid. These findings were confirmed by the aspiration of a moderate amount of bloody fluid. Eight days after operation the patient was comfortable, having no dyspnea and the dysphagia had diminished.

Roentgenograms on the thirteenth day (Fig. 3) revealed that the right chest was filling with fluid. On the afternoon of the same day there was serosanguineous discharge from the wound. Later 160 cc. of bloody fluid were aspirated. A small bronchial leak was discovered on the fifteenth day (Fig. 4). Intermittent suction drainage was established in the fifth space posteriorly on the seventeenth day.

On the nineteenth day, in the course of aspiration with a negative pressure water aspirator, the apparatus was incorrectly connected and ordinary cold tap water was delivered into the right chest cavity by mistake. The error was not discovered until the cavity became distended. The controls were then reversed and aspiration established. The accident caused considerable reaction. The temperature, which had been normal from the end of the first week, rose to 103.6°, the pulse to 112, respirations 32. The result was an empyema for which a posterior drainage had to be done. Culture of the pus showed *Staphylococcus albus hemolyticus*.

Despite the setback, the patient made a good recovery. Sixty-two days after operation, she walked eight city blocks with very little respiratory embarrassment. A small draining sinus still persists. Whether she will have to have the empyema cavity collapsed remains to be seen. At present the indication is that it will not be necessary.

A search of the literature reveals the fact that there have been very few successful one stage pneumectomies for carcinoma of the lung,¹ and that right pneumectomies are more infrequent than left, according to Overholt,² who performed the first successful right pneumectomy.

In conclusion it may be stated that we employed the technic described by Rienhoff.³ His anterolateral incision in the third interspace gave us a splendid exposure of the hilus of the lung.

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DISCUSSION.—DR. CARL EGGERS (New York) stated that successful resection of a lobe or of an entire lung for carcinoma is still sufficiently infrequent that each case deserves presentation and consideration not alone from the standpoint of diagnosis, but also of treatment. Much of the knowledge acquired in the past about malignant tumors of the lungs has had to be revised in the light of recent advancement on the basis of successful resections.

A patient with lobectomy for carcinoma presented by Doctor Eggers before the New York Surgical Society last year had been under observation for six months in different hospitals and by different physicians, and in whom repeated roentgen examinations, bronchoscopy and examination of the pleuritic exudate had failed to make a positive diagnosis. She was finally operated on six months after onset with a clinical diagnosis of cancer. A case like that shows how important it is to stress diagnosis, early diagnosis being essential to progress in surgery of the lungs, that is, diagnosis before the primary tumor has extended to involve surrounding vital organs, and before metastases have spread in the pleura or into the mediastinum. Even with an early diagnosis, however, not all lung tumors are suitable for operation. If a malignant growth involves the main bronchus close to the bifurcation, a safe closure is unlikely. If it involves the parenchyma close to the pleura it may have invaded the latter and spread metastases throughout the pleural cavity. A pleuritic exudate in a patient with suspected carcinoma of the lung is very suspicious. The most ideal case and in whom one may reasonably expect a good result is one with a single tumor at some distance from the main division of the bronchus and not too close to the pleura. In view of the difficulties connected with the diagnosis and treatment of these cases, the increased frequency with which lobectomies and pneumectomies are being reported is gratifying.

It is essential, of course, Doctor Eggers emphasized, to evaluate early symptoms. For a long time, there may be only cough—often dry and harassing, at other times productive and frequently blood stained. It is at this time that diagnosis should be made. When pain, dyspnea and pleuritic exudate are added, it may be too late. An early roentgenogram may determine the diagnosis. However, a tumor may simulate a chronic inflammatory lesion so that roentgen diagnosis is impossible, roentgenologists, like clinicians and surgeons, having a great deal to learn about the diagnosis of tumors. In any suspicious case, if the roentgen examination fails to clear up the diagnosis, a bronchoscopy should be done, with possibly a biopsy and bronchography. A pneumothorax may be done. A pleuritic exudate may be examined for tumor cells.

Even after a diagnosis has been made, there are many points to be considered. The approach to the lesion is important, that is, whether to go in anteriorly or posteriorly. The former may be easier in certain cases, but in the event of extensive adhesions a wide posterior approach might be better. The care of the stump is tremendously important, as is, also, the question of drainage.

DR. GEORGE J. HEUER (New York) knew of only six cases of successful total pneumectomy for carcinoma of the lung besides that of Doctor Lyle. Partial operations, such as resection, lobectomy, *etc.*, have not yielded very brilliant results. Since 1920 there have been 33 resections or lobectomies with a primary mortality of 39 per cent. Of the 20 patients who survived operation, 14 died or were living less than one year, one was living two years, two were living more than two years, and two were considered cured. Although this is a great advance over what obtained in this disease previously, it is hoped that earlier diagnosis with total pneumectomy will further improve the results. In spite of having personally explored a number of cases of carcinoma of the lung, Doctor Heuer said that he had not yet been fortunate enough to see a case in which total pneumectomy was feasible. There had been implantations in the mediastinum, upon the pericardium, and so forth, which made total pneumectomy unwise, even though it was technically possible.

TOTAL REMOVAL OF THE LEFT LUNG FOR CARCINOMA*

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PHILADELPHIA, PA.

CASE REPORT

R. S., a white male, aged 46, entered the Pennsylvania Hospital April 9, 1934, complaining of pain in the left side of the chest. He had a common cold in December, 1933, following which he had a persistent cough, expectoration of thick yellow sputum, and night sweats. These symptoms were accompanied by a dull pain in the left supraclavicular region, left shoulder and left upper chest. Coughing increased the pain. Shortness of breath on exertion became apparent shortly after the onset. He had lost 12 pounds since the onset of his symptoms. He had had no previous serious illnesses and there was no history of tuberculosis or cancer in his family.

On examination the patient did not appear ill. There was definite limitation of expansion and dullness on percussion over the left upper chest anteriorly. Vocal fremitus and vocal resonance were much diminished and breath sounds could scarcely be heard over this area. There were no other abnormal findings in the lungs. The heart was of normal size, and there were no cardiac murmurs. There was slight clubbing of the fingers, but no cyanosis. The blood pressure was 120/80. The blood Wassermann was negative. The hemoglobin was 83 per cent, and the red blood cells 3,300,000. The temperature and pulse rate were normal during two days' observation in the hospital.

A diagnosis of an obstructing lesion of the left upper lobe bronchus was made by Dr. P. A. Bishop on roentgenologic examination (Fig. 1). The left upper lobe was atelectatic. The trachea, superior mediastinum and aorta were displaced to the left and the left upper lobe showed compensatory emphysema. A shadow in the hilum region extending out into the upper lobe suggested an infiltrating lesion, probably bronchial carcinoma. Because of the marked displacement to the left of the trachea and the left main bronchus, it was impossible to visualize the orifice of the left upper lobe bronchus through the bronchoscope. Surgical exploration of the chest was advised, but the patient decided to leave the hospital and consider the question of operation later.

He was readmitted June 4, 1934. During the interval his cough had become worse and small amounts of blood appeared in the sputum every day. Dyspnea had increased and at times he had an asthmatic wheeze. The physical signs had not changed appreciably since the first admission. The vital capacity was 1,600 cc. June 5, 400 cc. of air were introduced into the left pleural cavity through the seventh interspace in the posterior axillary line. June 8, an additional 500 cc. of air were introduced, following which the intrapleural pressure became positive. After the pneumothorax had been produced roentgenologic examination showed slight compression of both upper and lower lobes and evidence of pleural adhesions.

A left total pneumonectomy was performed (by J. B. F.) June 13, 1934. The patient was anesthetized with tribromethanol (60 mg. per Kg. of body weight) supplemented by nitrous oxide. An incision was made from the sternum at the level of the third costal cartilage, curving downwards and outwards beneath the nipple to the posterior axillary line. The skin and subcutaneous tissues above the incision were reflected upwards and the pectoralis major and minor muscles were divided at the level of the fourth rib. The tissues in the third interspace were incised and the pleural cavity opened. The third costal cartilage was divided from within the chest, allowing greater separation of the third and fourth ribs. Firm adhesions were encountered at once. The fissure between the lobes was obliterated. The separation of adhesions was accomplished by blunt dissection and was tedious and time consuming. A hard mass about 10 cm. in diameter could be felt in the upper lobe close to the hilum. This was firmly adherent

* Read before the joint meeting of the Boston Surgical Society and the Philadelphia Academy of Surgery in Philadelphia, February 4, 1935.

CARCINOMA OF THE LUNG

to the pericardium over an area of several square centimeters. Rather than attempt the separation in this region, the pericardium was opened and the adherent portion excised, leaving it attached to the tumor. Two large mediastinal lymph nodes were removed, and carcinoma was reported on examination of the frozen sections from one of them. The lung was densely adherent along the spinal gutter and in the region of the arch of the aorta, and was separated with difficulty. Adhesions to the diaphragm were not disturbed at this time. In separating the upper lobe from the anterolateral aspect of the chest wall, thick yellow odorless pus was encountered. This was aspirated and a pack introduced. After freeing the region of the hilum, a ligature was placed around

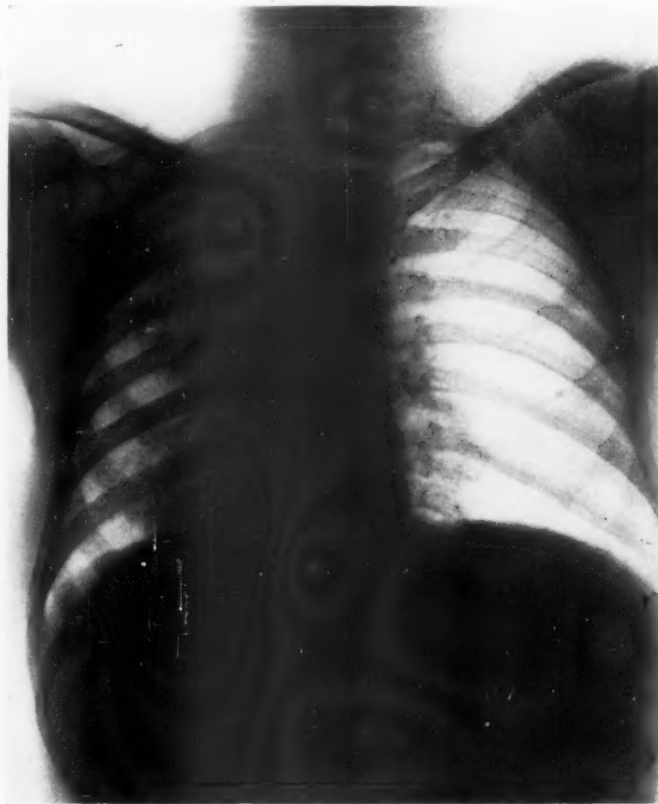


FIG. 1.—Roentgenogram made of the patient's chest three weeks prior to operation.

the pulmonary artery and tied. Clamps were placed on the pulmonary veins and the main bronchus and these structures divided. Adhesions to the diaphragm were then freed and the lung removed. While tying a ligature about one of the pulmonary veins, the gut broke and there was free bleeding for some seconds. The vessel was again clamped and tied. All blood vessels were ligated with No. 2 chromic gut. The clamp was removed from the bronchus and phenol was applied to the mucous membrane. The edges of the bronchus were caught with two sharp hooks and three mattress sutures of No. 00 chromic gut (using the type of sutures with needles affixed) were placed close to the cut end of the bronchus. The closure was reinforced with a continuous suture of the same type of gut. A piece of fatty tissue from the mediastinum was tied over the suture line. When the bronchial stump was released, it retracted almost out of sight into the mediastinal tissues. Two additional large soft lymph nodes were removed

from over the arch of the aorta and one from the mediastinum. The defect in the pericardium, through which the left auricular appendage prolapsed, was not closed. The



FIG. 2.—Photograph of the specimen removed at operation which has been sectioned to show the growth.

pleural cavity was quite dry at the end of the operation. Intrapulmonary pressure was raised to 8 Mm. of mercury without evidence of any air leaking from the bronchial

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stump. The wound was closed anatomically with interrupted sutures of chromic gut. Two pericostal sutures were placed about the third and fourth ribs. The skin was closed with silk. Shortly after removal of the lung, the patient's systolic blood pressure dropped to 70 Mm. of mercury. An intravenous infusion of 5 per cent glucose in normal saline was begun and continued until the operation was completed. The patient was then given 500 cc. of blood and placed in an oxygen tent.

A summary of the pathologic report follows: The fresh specimen (Fig. 2) consists of a left lung intact and several lymph nodes. The nodes range from $1\frac{1}{2}$ cm. to 3 cm. in maximum diameter. The largest shows an extensive whitish infiltration suggestive of tumor. The smaller ones appear normal except for anthracotic coloring. Externally the upper lobe is firm and the lower-lobe partially collapsed. There are extensive adhesions over the visceral pleura and at the apex there appears to be a patch of thickened parietal pleura attached to the lung. The two lobes are firmly adherent to each other throughout the course of the interlobar fissure. On section of the lung an irregular tumor mass 6 cm. in greatest diameter is seen medial to the midpoint of the upper lobe. This is yellowish white and firm. The border is slightly lobulated. Near the center of the mass remnants of a main branch bronchus can be seen in the shape of crescents of cartilage embedded within the tumor. Traced toward the hilum, extension of the tumor along the bronchus is evident with elevation of the mucosa. Lung tissue and vessels are compressed, and at one point a branch of the pulmonary artery is invaded by the tumor. The upper lobe distal to the tumor mass shows multiple large bronchiectatic cavities, up to 1 cm. in diameter, with smooth thick walls. The interlobar septum is 1 to 2 Mm. thick. The cut surface of the lower lobe shows no evidence of tumor.

Microscopically, the tumor cells have pale oval nuclei with a few chromatin granules and a well defined nuclear membrane. A squamous cell type is strongly suggested. There are moderate numbers of hyperchromatic nuclei and mitotic figures. Many of the tumor islands have necrotic centers. The advancing border is irregular and the appearance is one of rather rapid growth. Extension along a large bronchus with invasion of its wall is well shown. A round cell and fibrous infiltration surrounds the bronchiectatic cavities whose lining epithelium is in most cases well preserved. The same interstitial changes are seen in the more distant portions of the upper lobe. Here the alveolar septa tend to be better preserved and the alveoli are frequently occupied by numerous polygonal phagocytic cells, containing pale brownish granules. Areas of actual pneumonia are not seen. The interlobar septum is thickened by vascular, partially hyalinized, fibrous tissue rather heavily infiltrated by round cells, but not invaded by tumor cells. Round cell infiltration is intense in the portion of the upper lobe bordering on this septum. The cavities in the lower portion of the upper lobe are more poorly defined and contain cellular debris. The lower lobe is the seat of vascular congestion, moderately advanced patchy atelectasis and frequent small collections of heart failure cells, but apparently has escaped malignant invasion. Metastatic growth in lymph nodes resemble the primary tumor except for a greater tendency to necrosis. *Pneumococcus*, Type 3, was cultured from the pus of the loculated empyema encountered at operation.

A diagnosis was made of carcinoma of the left upper lobe with metastasis to the regional lymph nodes, and bronchiectasis of the left upper lobe secondary to bronchial obstruction by the tumor.

The patient's voice was hoarse immediately after the operation. The oxygen tent was used for several days. Serosanguineous fluid was aspirated from the chest on the second postoperative day. *Pneumococcus* and *Staphylococcus albus hemolyticus* were cultured from the fluid. The fluid gradually became purulent on repeated aspirations. One week after operation closed drainage was instituted through a No. 22 French catheter in the fifth interspace in the posterior axillary line. The sutures were removed on the ninth day. Two days later the patient coughed and expectorated some

reddish pus. This did not recur and was the only evidence of a bronchial fistula that was observed. A small opening at the medial end of the incision was also noted on the same day.

Because of the persistence of irregular fever and pain from pressure of the catheter between the ribs, open drainage was performed one month after operation under local anesthesia. Small portions of the fourth and fifth ribs were removed and tubes inserted. Because the drainage was blood tinged and the pain persisted, the old operative wound was opened five days later under avertin anesthesia. The third rib at the sternal end had separated from the cartilage and obviously was infected. It was removed as far back as the midaxillary line. An additional portion of the sternal end of the fourth rib also was excised. The chest cavity was explored. The diaphragm reached the level of the fourth rib and the mediastinal structures had shifted somewhat to the left. No trace of the bronchus could be found. The outline of the arch of the aorta could be seen. The cavity was lined with granulations, and in several areas catgut ligatures could be seen, about which there were depressions in the granulation tissue and a little pus. The bloody pus apparently came from the granulation tissue surrounding the necrotic third rib. The cavity was packed with 1 to 1,000 acriflavine gauze.

The infection cleared up rapidly following the operation, and the empyema cavity gradually diminished in size. August 17, about two months after the pneumonectomy, an upper posterior paravertebral thoracoplasty was performed to hasten the obliteration of the cavity. The fourth, fifth and sixth ribs were removed from the transverse processes to the point of previous section. In addition 7.5 cm. of the first, 11.5 cm. of the second, 14 cm. of the third, and 10 cm. of the seventh ribs were resected. The wound was closed without drainage.

The cavity was greatly diminished in size by the operation, and 11 days after operation the patient was allowed out of bed in a chair. Activity was gradually increased, and by the middle of September, three months after the pneumonectomy, the patient was up and about the greater part of the time. Roentgen ray therapy was begun at this time. One month later, on October 15, the posterior wound was opened and a small pocket of pus drained. At the same time a piece of necrotic third rib cartilage was removed.

In November a small tender swelling appeared in the eleventh interspace 7 cm. from the midline posteriorly. The roentgenogram showed some destruction of the lower border of the eleventh rib and the upper border of the twelfth rib in this region. Under local anesthesia the nodule was exposed and found to be neoplastic. A biopsy was done and a 50 mg. capsule of radium introduced. The capsule was removed 28 hours later. The tissue removed was metastatic carcinoma. The nodule diminished rapidly in size after the radiation and the patient was removed to a convalescent home in December. He still had small draining sinuses in both anterior and posterior wounds and some cough and expectoration.

He returned to the hospital in January, 1935, for roentgenologic examination and bronchoscopy. His condition had not improved since leaving the hospital. No new lesions were found roentgenographically. Ulceration of the blind end of the left main bronchus was seen through the bronchoscope and thought to be due to a recurrence of the growth.

NOTE.—The patient's condition became steadily worse in the hospital and he died February 27 from hemorrhage from the anterior chest wound. Autopsy showed a local recurrence of the growth about the left bronchial stump and the adjacent lymph nodes were involved. A portion of the recurrent growth had become necrotic, forming an abscess in the posterior portion of the remaining pleural cavity. The abscess communicated with the lumen of the left bronchus by a small sinus tract. The hemorrhage occurred from erosion of a blood vessel. Aside from this local recurrence and the nodule in the left eleventh interspace there was no other evidence of tumor. The right lung and its tributary lymph nodes were not invaded by the growth.

MEDIASTINOTOMY FOR SUBSTERNAL GOITER*

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ENLARGEMENT or prolongation of the thyroid gland behind the sternum in the thoracic cavity are interchangeably called substernal or intrathoracic, though the latter is more commonly applied when the greater portion or a considerable amount of the gland lies in the superior mediastinum. It is not at all uncommon for goiters to be partially substernal. The pathology is almost always an adenoma or a malignant neoplasm, rather than Graves¹ disease. An adenoma located in the lower pole of a thyroid lobe grows by following the path of least resistance into the superior mediastinum.

The more snugly the tumor is wedged in the superior thoracic aperture, the more pronounced are the symptoms, most often due to tracheal compression. These patients have varying degrees of dyspnea, with inspiratory stridor, choking and coughing spells, the next commonest symptoms being dilated neck veins, laryngeal cord paralysis, and dysphagia.

At operation the usual collar incision is made and the ribbon muscles divided. The superior thyroid arteries are divided and ligated and likewise the middle thyroid veins. Next, the isthmus is split and the lobes freed from the trachea, from above downward. In most substernal goiters, the inferior thyroid artery which enters the gland near the middle of the lobe remains in the neck and may be divided before the substernal portion is attacked. Fortunately, all the blood supply of an intrathoracic goiter descends from above downward with the descent of the goiter. Attempts to pull the tumor out by hooks and clamps usually result in tearing of the gland and bleeding. The most certain way is to insert a finger into the mediastinum, sweep the finger about the tumor to free it from its enveloping connective tissue and pry the growth out by pressure from below upward. This finger is more safely passed behind than in front as there are no veins posteriorly to be torn. Rarely, the size of the intrathoracic tumor makes it necessary to split the sternum.

CASE REPORT

A colored woman, 50 years old, had had since puberty a small lump in her thyroid gland. For five years there had been progressive enlargement of the gland with increased difficulty in breathing. For two years there were shortness of breath, swelling of the ankles, and other symptoms and signs indicating impaired heart function. For two months she had had severe attacks of dyspnea, worse at night, feeling at times as though she were choking to death.

Physical examination revealed a large adenomatous goiter, extending on the left to the trapezius and on the right to the sternocleidomastoid muscle. There was marked dulness over the sternum. Roentgenologic examination revealed a mass extending from the cervical area into the mediastinum well below the level of the aortic arch. The mass measured at a maximum four and one-half inches in diameter extending to right and left of the midline, though more prominent on the left and resulting in marked tracheal

* Read before the New York Surgical Society, March 27, 1935.

compression and deviation to the right; the esophageal lumen was also compressed and displaced.

Operation was advised but was declined until increasing dyspnea and the fear of choking to death led the patient to accept surgical intervention. She was considered a poor surgical risk due to her myocarditis.

Operation.—August 30, 1934, under ethylene anesthesia, the superior pole and the lateral masses were easily freed and the blood vessels ligated, leaving a small portion of the upper right lobe. It was impossible to insert a finger into the thoracic aperture, either from behind or from in front of the mass. There were numerous veins, some of them the size of one's little finger. Traction on the intrathoracic mass was of no avail. The fear of hemorrhage and the strong possibility of malignant changes in the tumor contraindicated morcellation and led to the adoption of the method used by Lilienthal who in 1915 split the sternum to remove an intrathoracic goiter. Accordingly, the manubrium and sternum were split in the midline downward for six inches with a chisel, whereupon, after retraction of the separated sternum, the mass was easily delivered without hemorrhage and with no respiratory embarrassment. The aorta and heart were readily visualized and a large pad inserted into the mediastinum. Ten minutes after removal of the mediastinal tumor and during the process of suturing the wound, the pulse stopped abruptly and the patient ceased to breathe, efforts to resuscitate were of no avail. Up to this time the pulse had not gone above 96 per minute and there was never any interference with respiration. While no autopsy was permitted, death was probably due to embolism, there being no evidence of pulmonary collapse.

The pathologist reported the tumor to weigh 338 Gm., a trilobed mass, each lobe measuring 140 by 90 by 60 Mm. and 90 by 55 by 30 Mm. and an isthmus connecting these two lobes measured 55 by 45 by 30 Mm. The tumor was a highly malignant adenocarcinoma, partly solid in type, with extensive necrosis and cyst formation, suggesting origin in fetal adenomata.

This case is of interest because the large size of the intrathoracic goiter necessitated splitting the sternum, a method rarely necessary and reserved only for the large and difficult intrathoracic goiters. The failure of the patient to survive should not condemn the method but should serve as an argument for early operation upon all goiters tending to become substernal, before advancing age with increasingly poor physical condition and the necessity of a more difficult and hazardous operation make the prognosis worse.

TOTAL THYROIDECTOMY FOR CONGESTIVE HEART FAILURE AND ANGINA PECTORIS*

REPORT OF THREE CASES

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THREE cases of total thyroidectomy from the First Surgical Division of Bellevue Hospital are presented. One of these was for congestive failure and two for angina pectoris.

CASE REPORTS

CASE I.—A male, 49 years old, had had symptoms of heart disease for 12 years and had had to give up his work in 1926. In the period from 1930 to 1934 he was admitted to Bellevue six times for severe decompensation. In the intervals he was not suf-

* Presented before the New York Surgical Society, April 10, 1935.

THYROIDECTOMY FOR ANGINA PECTORIS

ficiently well to work. At the time of his last admission he could walk only half a block or go up a few steps without resting, and was suffering from marked dyspnea, orthopnea, exertional precordial distress and palpitation. On examination he presented pulsating cervical veins, a hydrothorax which required tapping twice during his preoperative stay, and a liver enlarged to three and one-half fingers below the costal margin and for a time pulsating. There was marked edema of the extremities. The heart was enlarged, fibrillating, and showed signs of a double mitral lesion and of aortic insufficiency. The basal metabolism rate was +11.

Operation was decided on because of the increasing frequency with which hospitalization was becoming necessary and the diminishing degree of improvement with rest. Total thyroidectomy was done February 9, 1934. The surgical course was uneventful, aside from a slight wound infection. The precordial distress and palpitation were immediately improved and disappeared entirely after a week. Orthopnea was entirely relieved after 16 days. The liver remained down about two fingers, but did not pulsate and was not tender. He was discharged on the twenty-eighth day. Ten weeks later he had a recurrence of moderately severe signs of congestive failure—dyspnea, cough and edema. He was readmitted and discharged on the eighteenth day, relieved by rest, digitalis and salyrgan.

The metabolism rate was -17 for one week after operation, gradually falling to -42 eight weeks later, then rising to -24 six months after the thyroidectomy. Thyroid was started at this time, at first $\frac{1}{4}$ grain a day, later $\frac{1}{2}$. On this dosage the metabolism rate has varied between -17 and -26.

Blood cholesterol has ranged between 330 and 380 mg. during the past eight months. Before that time it was 165 mg.

At present the patient is able to walk four blocks moderately rapidly without distress and can climb one flight of stairs. He has not required hospitalization for ten months, a longer period of freedom than any enjoyed during the preceding four years. While unable to undertake much physical exertion, he is free from palpitation and distress, as well as from edema and the discomfort resulting from an enlarged, pulsating liver. There is a mild degree of myxedema. Subjectively, he feels better than for some years. Although not a brilliant result, it is felt that the patient has been definitely improved and has been made more comfortable by operation.

CASE II.—A male, aged 54, had a coronary occlusion in 1925, was in bed four weeks, and unable to work for seven months at his occupation of an insurance agent because of cardiac pain. A similar attack in 1928 kept him in bed eight weeks. Since that time he has been unable to work because of exertional pain. The pain when first noticed in 1925 was precordial. In 1928 it began to radiate down the left arm and was brought on by exertion. Nitrites gave little relief. In 1932 attacks of pain began to come on while at rest, and at the time of his admission to Bellevue in 1934 attacks of pain occurred hourly or even more frequently. At this time walking ten steps on level ground would bring on an attack. There was moderate dyspnea and frequent attacks of dizziness with transient syncope. Sleep was frequently interrupted by attacks of pain.

On examination, blood pressure was 128/100; metabolic rate +4. The heart was slightly enlarged to the left. The electrocardiogram showed evidence of marked myocardial changes.

Operation was decided upon because of the steady increase in severity of the symptoms, which could be relieved only by morphine. Total thyroidectomy was done March 20, 1934. The postoperative course was uneventful except for a tracheitis. There has been no recurrence of the preoperative pain since operation, although there have been occasional mild sensations of precordial oppression following excessive exercise, none severe enough to be really disturbing. There has been no recurrence of dyspnea, edema, or palpitation, and the only comment about sleep is that he sleeps "too much."

The metabolic rate fell to -39 in four weeks, at which time signs of myxedema

appeared. Thyroid $\frac{1}{2}$ grain a day was started in the seventh week and dropped to $\frac{1}{4}$ grain after four months. At present his rate ranges between -10 and -30. Blood cholesterol was 165 mg. one month after operation, but now ranges between 260 and 370 mg.

This operation has been highly justified in this case as it has enabled a patient who had been compelled to give up his occupation for six years to return to a relatively normal life, free from pain.

CASE III.—A male, 46 years of age, had had cardiac symptoms since 1932 and had been forced to give up his work because of the steadily increasing severity of attacks of pain. These attacks were a stabbing paroxysmal pain radiating to the left arm and lasting from a few seconds to a few minutes. At first brought on only by exertion, they had latterly come on two or three times a day or night while in bed. He had been in bed for three months before admission to the hospital, and during this time had found immediate relief from amyl nitrite. Dyspnea, palpitation and heart consciousness had distressed him for over a year. He had been under treatment for two years in a diabetic clinic, but had not been given insulin on account of his angina. His blood sugar ranged from 185 to 224 mg. Basal metabolism was +11, his blood velocity 12 seconds, venous pressure 30 Mm. The cardiac diagnosis was arteriosclerotic heart disease, coronary sclerosis, angina pectoris, and anginal failure.

Operation was considered because of the increasing severity of the attacks in spite of prolonged bed rest, and was performed April 17, 1934. His postoperative course was complicated by a wound infection and by mild symptoms of tetany, easily controlled by calcium and viosterol.

The course of the diabetes was interesting in that, while the diet was unchanged, the blood sugar dropped to normal within 48 hours and the urine became sugar free. Since then the blood sugar has gradually returned to its previous level, but the urine has persistently remained sugar free.

The basal metabolism rate fell to -14 in the tenth week. At this time the patient complained of headaches and dizziness and thyroid was started $\frac{1}{4}$ grain a day. Since then, his rate has varied between -7 and -24 and there have been no severe symptoms of myxedema. The blood cholesterol now varies between 250 and 340 mg., blood velocity has decreased to 27 seconds, and the venous pressure to 41 Mm. The electrocardiogram shows no change.

Since operation, the patient has been free from pain except that in cold weather or after overexertion there is a mild sense of precordial pressure. This has never been severe, however, and is entirely different from the pain experienced before operation.

Comment.—In the last year Doctor Weeks, Doctor Grace and the author have operated on 16 of these cases, ten for congestive lesions, one of whom died, and six for angina. Of the surviving nine cases of congestive failure, two have been without result, in that after temporary improvement the subjective symptoms have recurred and the patients have gone back to bed life; three have been markedly improved, in that the symptoms of congestive failure were entirely relieved and they are in condition to go back to work; four have been moderately improved, in that the symptoms have been improved, although they have occasional attacks and have to resort to bed rest. These four, however, have not been able to go back to work.

Of the six angina cases there were no operative deaths, although one patient died three and one-half months after operation, presumably of coronary failure. This death emphasizes the fact that in doing this operation we

are not directly treating the disease, but are merely attempting to ease the symptoms for the time being. Of the other five patients, four have been markedly improved, in that they have been able to get about, have been free from pain, and have been able to return to work. One has been moderately improved, in that he has had moderate symptoms, occasionally having had to take nitrates, but considers his condition to be very much better.

The operation is done under block anesthesia rather than under local infiltration. At first, we did the operation from before backward, that is, we divided the superior and inferior thyroid vessels, freed the poles, cut the isthmus and then dissected the gland from before backward. But recently we have done it in the reverse direction, following the suggestion of Berlin and Blumgart, with the idea that although the operation is a little more difficult, nevertheless, in the cases where the line of the recurrent laryngeal nerve runs through the gland or between the gland and the zone of attachment to the trachea, it is probably easier to recognize it when we dissect the gland from behind forward. We have had one case in whom temporary parathyroid symptoms developed, easily controlled, and fortunately have not had any patients develop recurrent laryngeal paralysis.

It is an operation about which it is still a little early to be very dogmatic. We still do not know what our end-results are going to be, or how long these patients are going to be completely or partially relieved of their symptoms, but it is felt that it is of very distinct value in patients who have been bedridden and who face a life of considerable discomfort physically and, of course, economically. In many cases it is a procedure which we can offer with the feeling that we can relieve discomfort for the time being and perhaps bring the patient back to a moderately successful economic basis.

I do not know of any condition, not even including chest surgery, in which the liaison between the medical and surgical services has to be as close as in this type of case. It is the responsibility of the medical man to determine the operability of the individual, to get him into the best possible operative condition, and to look after him afterward. In addition to the necessity of coöperation between physician and surgeon, there must be the coöperation of the patient because we have to realize ourselves, and to make the patient realize, that the operation is not a cure, but merely one to relieve symptoms. The patient who has had a complete thyroidectomy must understand that he is going to be under medical care the rest of his life. The questions of activity, amount of thyroid, and the time when thyroid medication is to be given, are, of course, all questions that no one can determine beforehand.

One need not be limited in the length of the incision in connection with postoperative cosmetic results because it is important to obtain very free exposure of the gland. Particularly in congestive cases with dilated veins, it is very difficult to obtain complete hemostasis, and infection is perhaps a little more frequent than ordinarily is the case.

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DISCUSSION.—DR. I. OGDEN WOODRUFF (New York) confessed to feeling a little on the defensive regarding so serious an operation in the treatment of so medical a condition as angina pectoris and congestive heart failure. In the first place, it must be realized that the operation is not done as an attempt to cure any condition, but to relieve patients from conditions in life that have become intolerable. Nevertheless, one must give the problem serious thought before deciding to put a man in a condition where he must be continually near a supply of thyroid and a doctor to prevent the development of a very serious state of myxedema.

In Bellevue Hospital it was decided that there were three groups of cases in which one might be justified in considering such an operation. In one is included patients who are continuously decompensated and who, despite all medical treatment, cannot be improved. In another group are those who become moderately comfortable while in bed under treatment and digitalization, but who, after getting up—particularly after leaving the hospital—even under the conditions of a very restricted life, become decompensated so that many periods of hospitalization are necessary. In the third group are the anginal patients who have repeated attacks over long periods of time, even on bed rest or on the slightest exertion, and who are little or not at all influenced by medication.

The first operations were done on patients in whom a proper degree of compensation could not be restored by bed rest, and these cases represent the particularly bad results, in that operation did not help to restore them. Neither was the procedure satisfactory in general in patients with hypertension, particularly essential hypertension, or with a luetic heart. The best type of patient for the operation is the one who improves on hospitalization but immediately breaks down after his discharge, it being advisable practically to limit the procedure to the type of case with rheumatic heart disease.

It is essential to have a well organized service to take care of these patients if good results are to be achieved. Care is required not only beforehand, but afterward there must be repeated determinations of basal metabolic rate to ascertain when thyroid should be started, the dosage to be given, and at what level to keep the metabolic rate and cholesterol. The quantity of thyroid required to prevent the operated patient from going into myxedema is much less than that required for the spontaneous myxedematous patient, and the patients operated upon do not have the electrocardiographic findings or anemic changes reported in other patients with myxedema.

Among interesting complications might be mentioned an inexplicable peripheral neuritis. With regard to the general principles upon which the operation is based it should be remembered that in hyperthyroidism with a metabolic rate of $+30$ the circulation time is about twice as fast as normal, whereas if the metabolic rate is -30 the circulation time is about half as fast as normal. Moreover, in patients with congestive failure the circulation time is about half as fast as when they are compensated. On the assumption that the symptoms present in decompensation might be due to the fact that blood is not supplied through the organs sufficiently rapidly to carry on metabolic activities of the body, it was thought that if metabolic activities could be brought down to a point where the heart could maintain the circulation adequately for the metabolic needs, the symptoms might be relieved. The same principle applies in the angina pectoris cases; that is, in coronary sclerosis the heart is not able to supply blood at a sufficient rate for the metabolic requirements of the heart muscle. By cutting down these needs

THYROIDECTOMY FOR ANGINA PECTORIS

through removal of the thyroid, it was estimated that blood would be supplied sufficiently rapidly to take care of the needs with consequent disappearance of the symptoms. One or two points, however, are not yet entirely clear. In the first place, the relief of the symptoms in congestive heart failure comes very rapidly after operation, when there is practically no change in the amount of thyroid hormone in the circulation. In the angina pectoris group, as soon as the thyroid is removed from its bed, the patient states he has no pain though pain may have been experienced even on the table just previously. There would seem undoubtedly to be some association in these cases with the sympathetic system, this assumption being supported by the fact that angina pectoris patients are not nearly so sensitive to the injection of adrenalin following the operation as before. Doses that brought on an attack very readily prior to operation produce no response afterward.

DR. ALLEN O. WHIPPLE (New York) stressed a point of great therapeutic significance in the treatment of total thyroidectomy, that is, the placing of the patient in an oxygen atmosphere for two to three days before operation and for several days after it. This therapy takes a considerable load off the circulation by supplying the individual with oxygen both before and after operation and is particularly valuable in cases of cardiac congestion due to valvular disease.

DR. SEWARD ERDMAN (New York) asked whether some of the benefits encountered after operation might not be due, in part, to the unusual guidance, medication and check up that these patients are receiving.

DOCTOR MCCREERY said that although the oxygen tent had not yet been used at Bellevue Hospital, they expected to use it very soon. He admitted that the definitely subjective improvement during and immediately after operation might be due partially to excessive preoperative care, but could not believe it to be the entire explanation.

DR. CARNES WEEKS (New York) said that the employment of total thyroidectomy in the treatment of heart disease was only a little over two and one-half years old. A questionnaire sent by him to various clinics where the operation might have been done developed that it had been performed 250 times in 26 clinics throughout the country with a surprisingly small immediate postoperative mortality. In the few cases that developed parathyroid tetany this was apparently transient and mild, being controlled by viosterol and calcium therapy. The number of recurrent nerve injuries was also astonishingly small. The appended three tables summarize the answers to this questionnaire.

TABLE I

Statistical Questionnaire on Total Thyroidectomy for Heart Disease

(Operation done in 26 clinics)

Total number of operations.....	250
Operative mortality.....	6.8%
Complications:	
Parathyroid tetany.....	8
(Transient, mild, controlled by viosterol and calcium therapy)	
Recurrent laryngeal nerve paralysis.....	13
(Four temporary)	

TABLE II

Results of Total Thyroidectomy for Congestive Heart Failure

(Operation done in 26 clinics)

Number of cases.....	150
Deaths:	
Immediate.....	14- 9.3%
Late (not related to operation).....	24-16%
Clinical results in 112 patients:	
Markedly improved.....	47-41.9%
(No recurrence of signs of symptoms of congestive failure: able to work)	
Moderately improved.....	44-39.2%
(Attacks of congestive failure less frequently and less severe; unable to work)	
No improvement.....	21-18.7%

TABLE III

Total Thyroidectomy for Angina Pectoris

(Operation done in 26 clinics)

Number of cases.....	100
Deaths:	
Immediate.....	3- 3%
Late (not related to operation).....	15-15%
Clinical results in 82 patients:	
Markedly improved.....	42-51.2%
(No pain, no nitroglycerine, normal activity)	
Moderately improved.....	33-40.2%
(Mild attacks of pain at irregular intervals, occasional use of nitroglycerine)	
No improvement.....	7- 8.5%

HIRSCHSPRUNG'S DISEASE*

FRANK L. MELENEY, M.D.

NEW YORK, N. Y.

CASE REPORT

E. C., a college boy of 18, was admitted to the Presbyterian Hospital February 3, 1934 (No. 405406), with a history of abdominal distention existing since birth. He had never had a spontaneous bowel movement. By sheer grit and determination his father had managed to keep him alive. During the first few years it required daily or twice daily bowel irrigations to relieve the distention. When 20 months old he was studied by Doctor Holt in the Babies' Hospital because of emaciation, distention and vomiting. At that time his hemoglobin was down to 10 per cent. He was transfused, but this did not seem to benefit him greatly, and he was expected to die. However, his father persisted in controlling the distention and he began gradually to improve. Although he was always embarrassed and handicapped by his large abdomen, he grew stronger gradually. His mental development had been normal.

Three years before admission, a barium enema revealed an enormously dilated colon

* Presented before the New York Surgical Society, April 24, 1935.

HIRSCHSPRUNG'S DISEASE

on the left side. With colonic lavage once or twice a week during the past few years, there has been some improvement in the degree of distention. A subsequent radiogram taken one and one-half years before admission seemed to indicate some reduction in the size of the colon, but there had never been any impulse for a spontaneous evacuation and the patient was determined to have something done, if possible, to relieve the condition. With the many reports, in the recent literature, of favorable results following lumbar ganglionectomy in similar cases, we advised operation, explaining to the parents that the results had been more satisfactory in younger than in older patients.

At operation February 5, 1934, under spinal anesthesia, it was found that the dilatation began abruptly at the middle of the transverse colon and extended down to the lower sigmoid, corresponding closely with the distribution of the inferior mesenteric vessels. The greatest dilatation was present in the sigmoid, which measured approximately 20 cm. in diameter. Without much difficulty, the left sympathetic cord was resected to include the second, third and fourth lumbar ganglia.

The patient made a very satisfactory recovery from the operation, but we were frankly disappointed when there was no resultant improvement in evacuation. A barium

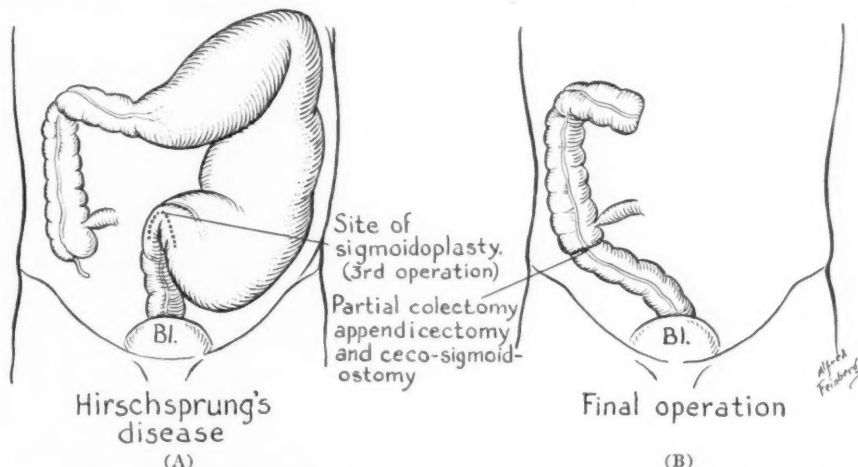


FIG. 1.—(A) Site of sigmoidoplasty performed at the third operation. (B) Showing anatomic result, after partial colectomy and ceco-sigmoidostomy (fourth operation).

enema two weeks after operation revealed a considerable reduction in the size of the colon but a failure to fill the lower segment. In the erect posture, the dilated portion hung down as a bag, evidently angulating the gut at the point of constriction. He was able to expel enemata, however, and was sent home with the expectation that he would improve under antispasmodics and retention oil enemata. Instead, the condition became steadily worse. Finally, after six weeks, he ceased to respond at all to enemata and came in again for roentgen study. This revealed more dilatation than at the previous examination and it was felt that an attempt should be made to assist the emptying of the dilated proximal portion into the distal contracted portion.

On April 9 a right-sided lumbar ganglionectomy was performed and the pre-aortic sympathetic fibers as well as those on the inferior mesenteric artery were cut. The dilated sigmoid was sutured by a series of silk stitches to the anterior abdominal wall. Again there was no immediate result but after two weeks he began to have spontaneous bowel movements for the first time. Improvement was transient, however, and it soon became apparent that the result would not be satisfactory. The distal sigmoid and rectum would not fill and the dilated portion would sag when he assumed the erect position. We attempted to dilate the narrow portion with rubber rectal bougies, but this merely resulted in pain and further constriction. On June 28 we performed a third operation

which was designed to make a larger opening between the dilated and constricted portions of the sigmoid. We protected the peritoneum by two injections of stool culture filtrate—one on the day before and the other on the morning of operation. When the peritoneum was opened, the expected purulent exudate was abundant. A curved incision was made, in a manner similar to that of a Finney pyloroplasty, and a large opening obtained (Fig. 1, A).

The patient recovered promptly from the operation and the wound healed without infection, although the fecal material still refused to pass into the distal segment. All that the operation accomplished was to bring the constriction lower down. After this failed to function, we again attempted dilatation and the boy's father continued this treatment throughout the summer. In the fall, however, the problem was still unsolved and it was decided to remove the diseased gut.

On October 23 the dilated gut was resected from the proximal transverse colon to the site of anastomosis. The distal sigmoid was then sutured to the cecum (Fig. 1, B), the appendix removed and a tube put into the cecum for a safety valve. The result was eminently satisfactory. The cecostomy tube functioned well. On the eighth day rectal lavage was administered and fecal material began to come down without difficulty. The cecostomy tube was removed on the eleventh day and two days later all of the fecal matter came through the rectum and was easily expelled with the aid of low enemata. On the sixteenth day he had a large spontaneous bowel movement and ever since then has had one or two spontaneous evacuations daily. He has gained rapidly in strength and weight, and in February, 1935, he returned to college. During the spring, summer and fall his bowel functioned normally.

DISCUSSION.—DR. EDWARD J. DONOVAN (New York) thought that it was difficult to understand why the ganglionectomy was not more successful in Doctor Meleney's case, but this occasionally happened. When talking to Doctor Adson of the Mayo Clinic about their cases of Hirschsprung's disease, he was informed that they had operated upon 20 cases with very gratifying results with the exception of one or two instances in which the results were rather disappointing in spite of the fact that they had done a ganglionectomy in addition to removal of the presacral and inferior mesenteric nerves.

Personally, he had had five cases, the first four being very successful and the fifth too recent to report upon. The first case was one in which Doctor Bolling had resected 48 cm. of the sigmoid for Hirschsprung's disease when the patient was ten years of age. There was a very prompt recurrence of the symptoms after this operation. When the boy was 22 years old Doctor Donovan performed a sympathectomy with excellent results. That was more than three years ago and he has had a normal bowel movement daily. The succeeding three cases were in children in whom the results were excellent.

Although not giving a good result in every case, Doctor Donovan felt that sympathectomy was very much better than the old method of resection of the intestines. Not only is the latter a rather severe operation to do on a child, but the results were very discouraging as exemplified by two cases of resection of the sigmoid for Hirschsprung's disease shown by Doctor Bolling before the New York Surgical Society, both of whom had recurrence of their trouble within a year.

DOCTOR MELENEY expressed his opinion that the reason that the results may be unsatisfactory in patients older than 12 years is because in the long period of time in which there has been great distention of the gut with the trauma that results from colonic irrigations, the wall of the gut develops extensive fibrosis so that even though the physiology may be restored by sympathectomy, the pathology represented by scar tissue in the wall, prevents

normal function. He felt that in the case reported it would have been better to have resorted directly to the resection after the first failure rather than to have attempted the other two conservative operations.

PRESACRAL SYMPATHETECTOMY FOR OBSTINATE CONSTIPATION *

J. WILLIAM HINTON, M.D.

NEW YORK, N. Y.

CASE REPORT

A young woman, 28 years of age, first examined May 31, 1932, complained of nervousness, irritability and inability to stand cold weather. For two months previously she had been treated for thyroid disease.

Past History.—The patient is married and has one child eight years of age. She had had no serious illnesses or surgical operations, but gave a history of constipation from birth, stating that for the first three months of her life she had never had a normal bowel movement and during childhood and adolescence had never had a movement without the aid of a cathartic. The constipation had grown gradually worse.

Physical Examination.—The eyes were negative for exophthalmos. There was no thyroid enlargement and no thrill over the neck. The skin was not flushed. There was no tremor of the fingers. The pulse was 80, the blood pressure 110/70. There was no definite evidence of thyroid disease except her basal metabolism was -11 . Her abdomen was not distended, contained no masses and tenderness could not be elicited. Rectal examination was negative.

In view of her minus metabolism and marked constipation, the patient was treated with thyroxine 1 mg. intravenously once a week for six injections and given thyroid Gr. 1, T.I.D. Although her basal metabolism on July 19, 1932, was -4 , the patient did not notice definite improvement in her symptoms. Between July 19 and October 7, 1932, thyroxine was given every two weeks and thyroid Gr. 1, B.I.D. On October 7 her basal metabolism was -2 and she complained of nervousness on taking the thyroid by mouth. This was discontinued and on November 3 her basal metabolism was -8 . She was then given thyroxine 1 mg. every two weeks without thyroid by mouth, but her general symptoms and constipation did not improve.

Radiographic examination, December 2, 1934.—A film of the abdomen before any barium was administered showed a large loop of the left side of the colon filled with gas and considerable accumulation of fine grained gaseous and solid material in the sigmoid. A barium enema showed a large colon, though not to the degree of a true megalocolon. The sigmoid is fairly long. By turning the patient in different positions, it was possible to visualize all of the colon quite satisfactorily, and no filling defects were found that could not be accounted for by fecal material. A small amount of barium passed into the ileum. A film made standing after evacuation showed the splenic flexure in the normal position and the hepatic well above the crest of the ileum directly beneath the apparently normal liver. Much barium was still in the colon and fluid levels of barium, water, and gas were found in several places in the colon. The appendix was not recognized. This is a case of apparently simple enlargement of the colon to about double the normal diameter, with moderate elongation. The expulsive function was poor.

Thyroxine was discontinued and the patient was given tincture of belladonna without any relief. At this time the suggestion was made that an operation might be needed

* Presented before the New York Surgical Society, February 27, 1935.

to cure the constipation and the patient readily assented. However, I hesitated to subject her to a presacral sympathectomy, being dubious of the result. On March 2, 1933, her basal metabolism was -15 . She was again put on thyroxine once every two weeks and thyroid Gr. 1, B.I.D.; this was continued until April 30, without benefit. The patient then entered the Post-Graduate Hospital for operation.

Operation, May 1, 1933.—The abdomen was opened through a midline incision. The posterior peritoneum over the aorta was then divided. The aorta and division of the iliacs were exposed and all the sympathetic fibers over the aorta were removed. Tissue on both the right and left sides resembling sympathetic ganglion was excised. An appendectomy was done.

Diagnosis.—Chronic productive inflammation of vermiform appendix resulting in atrophy and obliteration of the lumen. Mild chronic productive inflammation of lymph nodes with resulting atrophic changes. No sympathetic nerve fibers or ganglion cells were recognized in these sections.

Postoperative Course.—No cathartic or enema was given until the seventh day postoperative when an enema was very effectual. Since then none has been necessary, or any cathartics, the bowel movements having been regular and the patient entirely well except that for the past four or six weeks she has been slightly constipated, but not in a degree to compare to the previous condition.

A barium enema February 25, 1935, revealed the following: "A great deal of fecal matter is present. Without the previous films for comparison, I cannot say just what difference there is from the examination on December 2, 1932, before the sympathectomy, but I would say that this colon is double the normal diameter. There is quite a long sigmoid which does not show any evidence of organic disease. The patient expelled some of the enema and films showed considerable remaining. She then expelled more and the final film after evacuation does not show a great deal remaining. The left side of the colon was considerably wider than normal during and after the enema. It did not empty out its fecal contents as well as it should. As before, some barium passed into the ileum."

Comment.—It is emphasized that this patient had gas-oxygen-ether anesthesia and so the result, therefore, cannot be attributed to the effect of spinal anesthesia on the sympathetics. A long follow up in all these cases is most important.

DISCUSSION.—DR. EDWARD W. PETERSON said that a woman who, after being constipated all her life, had had two years of relief from her constipation following sympathectomy is a splendid result, even though she may be having slight trouble at present.

It is to Royle, an orthopedic surgeon, and to the late John Hunter, an anatomist, both of Sidney, Australia, that credit is due for the revival of and continued interest in surgery of the sympathetic nervous system. Royle attempted to relieve the spasticity or rigidity following war wounds of the central nervous system and reported encouraging results following lumbar sympathetic ganglionectomy. Unfortunately, the promise of benefit was not confirmed by many other workers in this field. Two interesting observations, however, resulted from this work: (1) the capillary circulation was increased and the temperature of the skin was permanently elevated in a sympathectomized limb; and (2) obstinate constipation, when present, was relieved in selected cases.

Applying this knowledge, Adson of the Mayo Clinic in March, 1925, operated upon a case of Raynaud's disease of the lower extremities, and, in 1926, Wade and Royle operated upon a case of Hirschsprung's disease, doing lumbar sympathetic ramisection, with an excellent result. Following a re-

port of this case, Adson, Judd, Rankin and Learmouth, of the Mayo Clinic, Wade, Scott, and surgeons in this country and abroad, reported encouragingly upon their experience with this operation. Three cases of Hirschsprung's disease successfully treated by lumbar sympathetic neurectomy were also reported by Doctor Peterson in 1933 at a joint meeting of the New York Surgical Society and the Philadelphia Academy of Surgery. More recently, Doctor Peterson said, a fourth case was operated upon by him with a satisfactory immediate result.

The method proposed by Wade, the original operator, was an extraperitoneal division of the paravertebral sympathetic cord below the fourth ganglion, with a division of all of the medially directed rami up to the level of the inferior mesenteric artery, through a long incision in the flank. Adson and Judd advocate, through an abdominal approach, bilateral ganglionectomy of the second, third, and fourth lumbar ganglia. Rankin and Learmouth believe that resection of the presacral and inferior mesenteric nerves will sever all of the branches to the parts of the bowel chiefly affected, thus avoiding the minor disadvantage of disturbing the neurovascular supply to the lower extremities. Doctor Peterson stated that there could be no question as to the value of this operation as performed by Doctor Hinton, in properly selected cases.

THE MATAS OPERATION IN THE TREATMENT OF ILIAC, FEMORAL AND POPLITEAL ANEURYSMS *

JOHN H. GIBBON, M.D.

PHILADELPHIA, PA.

DOCTOR GIBBON said that he had been impressed with Matas' early contributions on the treatment of aneurysm and has often regretted that the important principle laid down by him of dealing with the aneurysm from within the sac had not been more universally applied. During the late War, for instance, where there was extraordinary opportunity to apply the method, it was seldom used, particularly in the American Army. The French employed ligation and extirpation. Sencert reported 93 cases of extirpation during the War with nine cases of gangrene and says that gangrene is more frequent after ligation than after extirpation. The intrasaccular method was used by the Germans to some extent, but far less frequently by the French, English or Americans.

Doctor Gibbon did his first endo-aneurysmorrhaphy in 1904, and since then has done but two primary ligations for aneurysm of the lower extremity. The first was a case of popliteal aneurysm where a physician had punctured it, thinking it an abscess, and where there was a suppurating superficial wound on the front of the knee. Patient had fever and a leukocytosis. In the second case, the common iliac was ligated for a huge aneurysm of the external iliac which practically filled the pelvis.

Since 1904, he has done 22 obliterative endo-aneurysmorrhaphies on the large vessels of the leg. Eighteen of these were included in a paper read

* Read before the Joint Meeting of the Philadelphia Academy of Surgery and the Boston Surgical Society, February 4, 1935.

before the American Surgical Association in 1924. The distribution as to site was as follows:

Ileofemoral.....	2
Femoral.....	12
Popliteal.....	8

Deaths.—There were three deaths following operation; one was an anesthetic death just at the conclusion of the operation; one occurred 15 days after operation and 24 hours after a ligation of the femoral artery for secondary hemorrhage from the site of an obliterated popliteal aneurysm. The patient was in good condition following ligation and died very suddenly the next day; the autopsy showed a vegetative endocarditis and a splenic and renal infarction. The third death was in an extremely ill leucic Negress with a femoral aneurysm. The operation was done under local anesthesia because of a very grave cardiac condition. One week after the operation she had a hemorrhage from the site of operation which was controlled by reopening and resuturing. She died suddenly the next day without any more bleeding or any symptoms indicating impending death. The autopsy findings were acute and chronic endocarditis and aortitis; hypertrophy and dilatation of left ventricle; infarction of spleen and kidneys; atrophic cirrhosis of liver and vesicular emphysema of lungs.

Six of the 22 aneurysms were traumatic and three of these arteriovenous.

Gangrene. Amputations. Secondary Aneurysms.—In none of these cases, even in the fatal ones, did gangrene occur, and in none was amputation done. Most of these patients have been traced since operation and no secondary aneurysm has developed.

Postoperative Hemorrhage occurred in several cases, usually from one to three weeks after operation. Two resuturings failed and ligation was done, in one successfully. These later ligations are less apt to cause gangrene than primary ligation. In his experience, the traumatic arteriovenous aneurysms are more apt to bleed after operation than the others.

Technic.—Doctor Gibbon feels that from his experience the obliterative operation, because it is simpler and safer and gives satisfactory results, is preferable to the restorative and reconstructive operations in the vessels under consideration. Exception to this might be made in the case of saciform traumatic aneurysms and in certain arteriovenous aneurysms.

Control of Circulation.—The Matas operation is applicable wherever the circulation can be controlled during its performance. Doctor Gibbon felt very strongly that in aneurysms due to a diseased vessel all forms of mechanical control of the circulation were dangerous. Digital compression with or without exposure of the artery above the aneurysm was the method employed by him in all luetic aneurysms and in several of the traumatic ones. In the iliac and femoral aneurysms the abdomen was opened and the common or external iliac compressed by an assistant. He felt that any mechanical appliances such as tapes or clamps might be injurious to the diseased vessel

and recalled that there were several instances reported where an aneurysm subsequently developed at the site where such appliances had been used.

DISCUSSION.—**DOCTOR DAVID CHEEVER** (Boston, Mass.) wished to know if traumatic aneurysm did not lend itself to endo-aneurysmorrhaphy as well as the luetic or spontaneous type. Recent traumatic aneurysm has not the firm wall to work in.

DOCTOR GIBBON.—Recent traumatic aneurysms are just as easily operated on by this method and give excellent results; the long standing ones are more difficult. The traumatic type lends itself to the restorative operation of Matas in which the caliber of the vessel is preserved. He has never done the reconstructive operation, although he had tried it once unsuccessfully in an aneurysm of the abdominal aorta.

DEFORMITY DUE TO LOSS OF SUBSTANCE OF THE MANDIBLE FOLLOWING OSTEOMYELITIS*

ROBERT H. IVY, M.D., AND LAWRENCE CURTIS, M.D.

PHILADELPHIA, PA.

CASE REPORT.—E. B. female, aged 27, single, applied in June, 1933, for correction of facial deformity. At seven years of age she had osteomyelitis of the left side of the mandible, due to dental infection. Had several operations at that time. The end-result was loss of a segment of bone and several teeth on that side of the lower jaw. At ten years of age an unsuccessful attempt was made to restore the lost continuity by a rib graft. Since then she has been unable to use her lower jaw for mastication, and there has been a gradually increasing visible deformity, due to displacement and lack of growth of the mandible.

Examination in June, 1933, showed a retrusion of the chin and lower lip, which was overlapped by the upper teeth. The chin was drawn over to the left side. There was a concavity of the left cheek, extending from in front of the ear toward the chin (Fig. 1). Only three teeth remained in the lower jaw—the right second incisor, canine and first premolar. With the mouth closed these teeth were found to be drawn toward the left and posterior to the upper teeth so that there was no contact. Abnormal mobility of the mandible existed at about the region of the left mental foramen, and there appeared to be a gap in the bone from this point backward. Posteriorly, the left ascending ramus could be felt as an independent unit. The main fragment of the mandible was bound over to the left by scar tissue so that it was impossible to reduce it completely by manipulation.

Roentgenologic examination showed a gap in the left side of the mandible, beginning at about the region of the mental foramen, and extending to the angle. Running forward from the ramus segment and extending about halfway across the gap was a thin piece of bone, probably the remains of the rib transplant (Fig. 2).

Treatment.—In this case three distinct procedures were required: (1) Restoration of remaining fragments of the mandible to correct as nearly as possible the relationship with the upper jaw. (2) Restoration of the continuity of mandible by bone graft. (3) Improvement of the external symmetry of face.

(1) June 15, 1933, in the Graduate Hospital, the scar tissue binding the main part of the mandible over to the left was divided. This freed the bone and permitted slight overcorrection. Arch-bars were applied to the remaining lower teeth and all of the

* Read before the Philadelphia Academy of Surgery and the Boston Surgical Society, February 4, 1935.



FIG. 1.—External appearance before operation.



FIG. 2.—Roentgenogram showing defect in mandible before operation.

OSTEOMYELITIS OF MANDIBLE

upper teeth, and the two fastened together in a slightly overcorrected position. A waiting period was now necessary to allow complete healing of the mouth incision.

(2) July 27, 1933, under avertin-ether anesthesia, a three-inch skin incision was

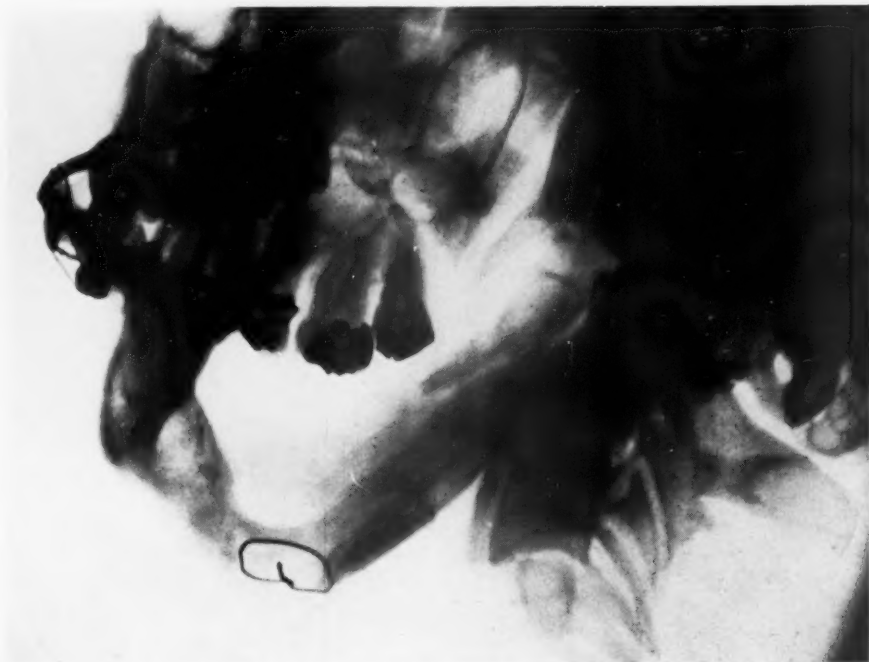


FIG. 3.—Roentgenogram showing defect filled by graft from crest of ilium.

made along the lower border of the mandible on the left side, and the gap exposed, care being taken not to perforate into the mouth. Scar tissue was removed, revealing the stump of the main mandibular fragment and the remains of the rib graft. These were



FIG. 4.—External appearance after operation.

thoroughly denuded of periosteum, the anterior stump being exposed for about three-quarters inch, and the outer surface of bone posteriorly being denuded to give a broad exposure back toward the ascending ramus. A bone graft, two and one-half inches

long, was removed from the crest of the left ilium with a metacarpal saw and chisel, and after trimming to suitable shape, was attached to the anterior fragment of the mandible by fine brass wire passed through holes drilled in the bone and in the graft. Posteriorly, the graft was laid against the outer surface of the ramus segment, in close contact (Fig. 3). The wound was closed in two layers, without drainage. Healing was uneventful (Fig. 4). The patient left the hospital after two weeks, and soon recovered full use of the limb from which the graft had been taken.

October 9, 1933, the fixation was removed from the teeth. Union of the graft was found to be firm, and the mandible stable, with good movement at the joints. Following this, a lower artificial denture was made, to restore the missing teeth.

(3) The bone graft filled out the concavity of the left side of the face, but there was some flattening to the right of the chin, due to distortion of the mandible from prolonged fixation in malposition.

March 16, 1934, under ether anesthesia, a piece of costal cartilage was inserted in a subcutaneous pocket against the outer surface of the mandible to the right of the chin. This had the effect of improving the symmetry of the face. Patient left the hospital after ten days. At present she has a greatly improved appearance, and her lower jaw has been put in a condition to function with an artificial denture.

DISCUSSION.—DR. VARAZTAD H. KAZANJIAN (Boston, Mass.) thought that cases in which the mandible was distorted owing to loss of bony tissue presented great difficulties. The mandible is a movable bone, and isolated segments of it are difficult to control. It is necessary to make intricate dental splints to immobilize the parts before the operation. In this case Doctor Ivy used a block of bone graft taken from the ilium. It had been the speaker's habit, in cases requiring extensive bone graft of the mandible, to use a series of thick osteoperiosteal grafts from the tibia, placed one over the other and held in position by suturing to the adjacent soft tissues with catgut. This was not a criticism of Doctor Ivy's method, but merely showed another way of accomplishing the same result. It was the speaker's impression that a series of osteoperiosteal grafts made a more flexible transplant, and as a result, the problem of immobilization was simplified.

MEMOIRS

JOSHUA CLAPP HUBBARD

1869-1934

JOSHUA CLAPP HUBBARD was born in Charlestown, New Hampshire, on December 31, 1869, the son of Richard and Sarah Denny (Clapp) Hubbard.



JOSHUA CLAPP HUBBARD, M.D.

He received the degree of A.B. from Harvard College in 1892 and M.D. from the Harvard Medical School in 1896. He served as Surgical House

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October 9, 1933, the fixation was removed from the teeth. Union of the graft was found to be firm, and the mandible stable, with good movement at the joints. Following this, a lower artificial denture was made, to restore the missing teeth.

(3) The bone graft filled out the concavity of the left side of the face, but there was some flattening to the right of the chin, due to distortion of the mandible from prolonged fixation in malposition.

March 16, 1934, under ether anesthesia, a piece of costal cartilage was inserted in a subcutaneous pocket against the outer surface of the mandible to the right of the chin. This had the effect of improving the symmetry of the face. Patient left the hospital after ten days. At present she has a greatly improved appearance, and her lower jaw has been put in a condition to function with an artificial denture.

DISCUSSION.—DR. VARAZTAD H. KAZANJIAN (Boston, Mass.) thought that cases in which the mandible was distorted owing to loss of bony tissue presented great difficulties. The mandible is a movable bone, and isolated segments of it are difficult to control. It is necessary to make intricate dental splints to immobilize the parts before the operation. In this case Doctor Ivy used a block of bone graft taken from the ilium. It had been the speaker's habit, in cases requiring extensive bone graft of the mandible, to use a series of thick osteoperiosteal grafts from the tibia, placed one over the other and held in position by suturing to the adjacent soft tissues with catgut. This was not a criticism of Doctor Ivy's method, but merely showed another way of accomplishing the same result. It was the speaker's impression that a series of osteoperiosteal grafts made a more flexible transplant, and as a result, the problem of immobilization was simplified.

MEMOIRS

JOSHUA CLAPP HUBBARD

1869-1934

JOSHUA CLAPP HUBBARD was born in Charlestown, New Hampshire, on December 31, 1869, the son of Richard and Sarah Denny (Clapp) Hubbard.



JOSHUA CLAPP HUBBARD, M.D.

He received the degree of A.B. from Harvard College in 1892 and M.D. from the Harvard Medical School in 1896. He served as Surgical House

Pupil at the Massachusetts General Hospital and later as Interne at the Boston Lying-In Hospital. Immediately after finishing his tour of duty at the Boston Lying-In Hospital he began the practice of his profession in Boston. While his chosen field was general surgery, he kept up an active but gradually decreasing interest in obstetrics.

During his early career he served on the staffs of various hospitals, the Boston Lying-In, the Carney, and the Infants'. Later he became Visiting Surgeon to the Boston City Hospital, Surgeon to the Newton Hospital and to the Leonard Morse Hospital in Natick, and Consulting Surgeon to the Norwood Hospital.

He began to teach in the Harvard Medical School in 1903 and continued in various positions, with one or two short interruptions, until 1924, when he was made Clinical Professor of Surgery. He was obliged to resign this position in 1928 because of increasing ill health, and at that time was made Professor Emeritus.

Doctor Hubbard's military service, while not long was highly creditable. He entered the Medical Reserve Corps U. S. A. in January, 1917, as a Major, and taught medical officers in Boston until he sailed for France with Base Hospital 85 on September 8, 1918. On his arrival in France he was promoted to Lieutenant-Colonel, M. C. U. S. A. He was stationed at Paris and Angers with Base Hospital 85 and later at Sebastopol Barracks with Evacuation Hospitals 1 and 37 as Chief of the Surgical Service. He was discharged at Camp Dix on May 15, 1919.

During the early part of his foreign service he was seriously ill with influenza, from which he never fully recovered. A severe arthritis followed and this in turn was followed by a rapidly progressing Parkinson's disease, from which he died on January 11, 1934.

During the early years of practice he wrote a moderate number of sane and valuable articles on surgical subjects, but this activity lessened as he became more and more occupied with his teachings and practice, and ceased when his health began to fail.

Doctor Hubbard was a typical New Englander with all the best qualities of that individual. Endowed with a Puritan conscience, he was honest beyond most men not only in his everyday life but also in his surgical work and teaching. Kindly and sympathetic beyond our ideas of the Puritan who was kindly and sympathetic toward those who believed as he did, Doctor Hubbard was kindly and sympathetic toward his patients, colleagues, and all those with whom he came in contact. A colleague has said of him that he doubted if any one ever heard him make an unkind or critical remark about a colleague. It was not in him to do so. He was modest beyond all reason.

What better qualities in addition to his professional attainments, which were considerable, could a clinical professor bring to his students? As a teacher he was earnest and able and was tremendously admired. He gave his students what they wanted and needed in a simple direct way which made his teaching effective. They were given a background for their professional

careers which should carry them safely over many rough places. It is to be hoped that these qualities so outstanding in Doctor Hubbard will always remain essential to the Clinical Professor of Surgery for they are needed by the men who must go out among people to care for them.

In surgery his method was simple, direct, and effective. This added to rare judgment and an excellent sense of proportion made him of great value to the community and to his students.

Doctor Hubbard was devoted to his profession, colleagues, and friends. Nothing was too hard for him to undertake in the interest of his friends or patients, and his kindliness, understanding sympathy, and surgical skill will always be remembered by his patients.

While all this is true of him, he was unusually devoted to his family and spent every possible moment with them at his place in the country. He was a lover of all out of doors.

His sterling qualities and their influence upon his colleagues, friends, and students have done much to make the world a better place to live in.

DANIEL F. JONES.

JABEZ NORTH JACKSON

1868-1935

JABEZ NORTH JACKSON was born in the little village of Labaddie, Missouri, on the sixth day of October, 1868. He died at his home in Kansas City on March 18, 1935.



JABEZ NORTH JACKSON, M.D.

The Jackson family came to Missouri from Virginia in the early days of Mid-Western settlement. Doctor Jackson's father was a physician of the pioneer type, serving for many years a small rural community and later as a Major with the Union Forces during the Civil War.

Doctor Jackson received his Bachelor of Arts and Master of Arts degrees from Central College, Fayette, Missouri. In 1891 he was graduated in medicine at the University Medical College in Kansas City, Missouri. Immediately following graduation he served his medical school as demonstrator in anatomy for several years and later became Professor of Anatomy. From 1900 to 1911 he held the chair of Professor of Principles and Practice of Surgery. For twenty years he was a Trustee of the University Medical College and during a portion of this time served as its President.

In 1927 Doctor Jackson was elected President of the American Medical Association. In addition to this honor he has successfully held the office of President in the Western Surgical Association, Missouri State Medical Association, county and various local medical organizations. He has received the honorary degrees of Doctor of Science and Doctor of Laws. He was a foundation member of the American College of Surgeons. Being the son of an army surgeon, Doctor Jackson inherited an interest in military affairs. He served as Major in the Spanish-American War in 1898. Both before and since he has been active in local military organizations and was for years, before his death, a member of the Medical Reserve Corps.

Doctor Jackson's best known contributions to surgery have been his description of membranous pericolicitis (Jackson's membrane) and a technic for breast amputation.

Among his friends and associates Doctor Jackson was always a favorite. In his later years he was affectionately called "Uncle Jabez" by his younger confreres in medicine. One of his outstanding characteristics was his unfailing loyalty to his friends. He was especially interested in the progress of the younger physicians, aiding and advising them whenever possible. He always preached the gospel of honesty in medicine. No man was ever more ready to rise to the defence of the medical profession when quacks, cults and isms threatened its high standing. He will forever live in memory as a surgeon, loyal friend and distinguished citizen.

THOMAS G. ORR.

JOHN EDWARD SUMMERS

1858-1935

JOHN E. SUMMERS died at his home in Omaha, Nebraska, on February 7, 1935, at the age of 77. He was born at Fort Kearney in the same state, in which for so many years he practiced his profession of surgery. His



JOHN EDWARD SUMMERS, M.D.

father was General John E. Summers of the Medical Corps of the United States Army. Amid such military surroundings, it was natural that he elected to follow an Army career. He entered West Point, but after three years re-

signed to matriculate at the College of Physicians and Surgeons in New York, from which school he graduated in 1881. The Army still called and he became an acting assistant surgeon. After serving nearly two years in the frontier posts of Wyoming, he again resigned and spent two years of study in Europe, chiefly in Vienna, returning in 1885 to locate in Omaha.

From data obtained from the Nebraska State Medical Journal of April, 1932, an issue honoring Doctor Summers, a formal statement is made of his many activities.

In 1887 he joined the faculty of the Omaha Medical College, was elected trustee in 1890, became Secretary of the Faculty in 1891 and President of the Board in 1897. He resigned in 1902 when the school affiliated with Nebraska University, to return later as Professor of Clinical Surgery, when the four year course in medicine was established, a position he held all through life. He was Past President of the Nebraska State Medical Society and the Medical Society of Missouri Valley; charter member and Past President of the Western Surgical Society, a member and in 1916 Vice President of the American Surgical Association; a Fellow and member of the Board of Governors of the American College of Surgeons and member of the Association of Military Surgeons. He was Surgeon in Chief and Senior Surgeon to the Clarkson Hospital, and for many years Chief Surgeon of the Douglas County Hospital; was on the staffs of the Immanuel and Wise Memorial Hospitals. He was at one time Surgeon General of the Nebraska National Guard. An Honorary Doctor of Laws degree was conferred upon him by the University of Nebraska.

Doctor Summers was a frequent contributor to the progress of medicine and surgery. His many formal papers cover a wide range of endeavor. He was the author of one book, "The Modern Treatment of Wounds." The records of his societies show many discussions of the efforts of others, an index of his general interest and ability. A computation of his book reviews runs to extraordinary figures.

In the 1880 period, in the Mid-West, surgery was on the threshold of the era of advancement and change in study and research, an effort which we now recognize as scientific medicine. The clinical men of that period had no recourse to the many refinements of diagnosis and technic that are at hand today. They were individual men, who depended upon their own judgment and experience. The form of practice was based so often on empiricism, the facilities of conduct were limited. Amid such surroundings came a young man trained by the discipline of the Army, by the best obtainable instruction of the Old World. He brought not only the ability to care for the ordinary run of surgical cases, but of special operations as well. In 1931 he wrote a paper entitled "Wayside Gleanings of a Pioneer Surgeon," a review of his work of over 46 years. He was the first to use the laryngoscope, the first to correct a wry neck, operate with recovery of the youngest patient for acute appendicitis, to do the first nephrectomy, the first choledoco-enterostomy, *etc.*

He became associated with the hospital and medical schools soon after his

arrival with ever-increasing interest as shown by his promotion to positions of responsibility in the conduct of their affairs of the institutions and the form of teaching in the schools.

Through the Western Surgical Association, of which he was a Charter Member, I came to know him as a most courteous gentleman, soft spoken, an attentive listener, a wise advisor. He was loyal and faithful in his duties and commitments. His contributions were of such merit, so well prepared that his name on the program brought a most attentive audience.

I felt that he had a high purpose in his profession, that no matter what the encouragement of reports of new methods of treatment, that his was a conservative attitude, which required careful weighing of new data and yet with all a progressive spirit of an open mind. The circumstances of his early practice, the development of his many innate faculties to the highest degree of efficiency as a surgeon, place him in that fast-disappearing group who pioneered in their respective fields, helped to sift and evaluate over the years, the findings of research and experiment and apply these findings to the clinical problems of his patients. Such a career—such a record of work—can be gained only by a heartfelt purpose and can be maintained only by the respect and appreciation of his fellows.

HARRY P. RITCHIE

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